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MACHINERY FOR CHARGING AND DRAWING GAS RETORTS.

THE most recent installation of Mr. John West's improved machinery for charging and drawing gas retorts was completed about six months ago by the West Gas Improvement Company for the Bradford Road Gas Works of the Manchester corporation. For our illustrations and the following particulars we are indebted to the *Engineer*, London. At these gas works the retort house is of the stage floor type, and has 28 beds of 24 in. by 16 in. D retorts, 20 ft. through, some beds having 8 retorts and some 9 in a setting. Before the machinery was put in operation some of the retorts were worked by manual labor on the old system of stoking, and the stokers charged each retort with from 3¼ cwt. to 3½ cwt. of coal per mouthpiece, or from 6½ cwt. to 7 cwt. per retort, and this amount was carbonized in 4 hours 48 minutes. The machinery has been designed for putting in at least 4 cwt. of coal per mouthpiece, or 8 cwt. per retort every 4 hours 48 minutes, and this amount is now being regularly charged. It is found in practice that when the coal is properly and evenly distributed in the retort, a considerably greater weight of coal can be carbonized in the same retorts in a given time.

From the fact that with machinery the coal is broken to a regular size, and is evenly charged throughout the length of the retort by the chargers, it arises that a greater quantity of coal can be carbonized per retort than is the case with ordinary hand labor. In this case the retorts are heated by a good system of regenerative firing, and there is no difficulty in attaining the heat for properly carbonizing the coal. The hot coke is drawn direct from the retorts into the furnaces by the drawing machine, or into wagons below the stage floor.

Since the machinery was first started on December 8 everything has gone on smoothly, and the men have learned to work it very quickly, proving that it is easily manipulated and simple in action. The whole plant is being worked as regards cost in accordance with a schedule submitted at the time of acceptance of the tender. In West's system the whole of the manipulation of the coal, from the time when it is delivered out of the railway wagons on the overhead railway in the coal stores until it is deposited as coke in the wagons below the stage floor, ready for removal to the coke yard, is done by machinery, without more manual labor than is necessary for attending to and working the machines. Four large cannel breakers are placed in the coal stores, two on each side of the retort house. Each breaker is independent of the others and is worked by a separate steam engine, and they have been designed to meet the requirements of the Bradford Road Works, where the cannel and coal consists chiefly of very large pieces, which have to be broken smaller before being placed in the retorts. The shafts, claws and gear have been made of steel throughout of very strong sections and massive proportions. These cannel breakers are the most powerful that have been constructed for gas works, and will break the largest and hardest cannel to a suitable size. The breakers are erected in pits below the floor line and are covered with iron flooring, supported by girders, and each floor has a door in it to allow of access from the retort house.

When the cannel or coal has been reduced to a suitable size by passing through the breakers, it falls, with smaller pieces which have not required to be broken, into the bottom of the pit, and round the bottom of the elevator, which runs in the pit, and then, by means of the buckets of the elevator, it is carried up to a large overhead hopper in the retort house. The elevators are constructed of strong detachable elevator chain and iron buckets, fitted with guides for sliding up and down a strong steel lattice framing, and they are driven from the cannel breakers by means of belts and chain gear. There are four overhead storage hoppers in the retort house, each constructed of steel plates and angles and supported by strong girders spanning from the outside walls to the retort stack. Each hopper is provided with two outlet doors at the bottom, which are opened or closed by hand levers fixed near the walls. The hoppers are placed at convenient positions in the retort house for the charging machine to pass under and take a supply of coals.

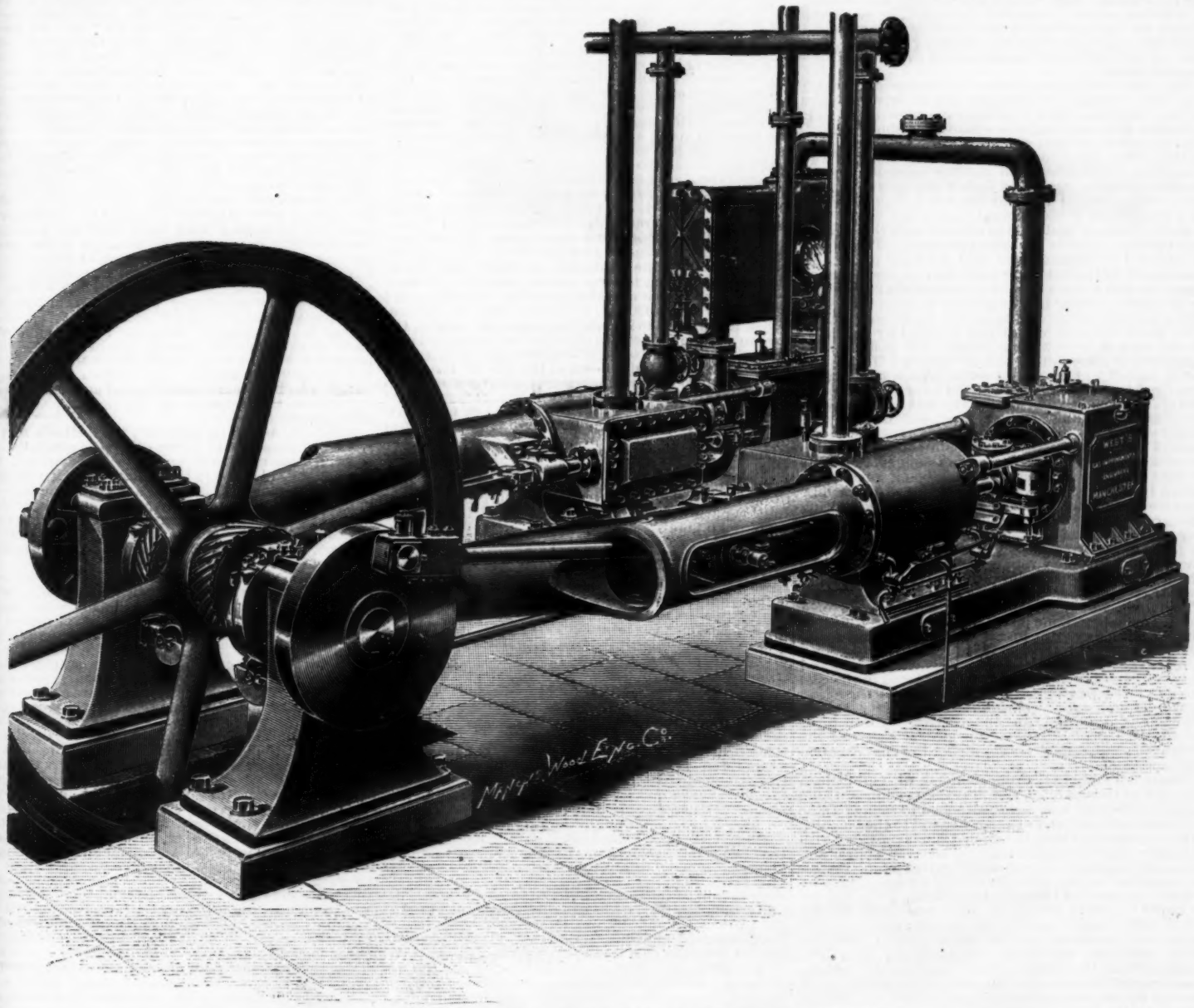


FIG. 1.—AIR COMPRESSOR, MANCHESTER GAS WORKS.

The charging machines are fitted with propelling gear for traveling up and down the retort house on rails laid parallel with the retort stack. Each machine carries a supply of coal in an adjustable hopper, supported by chains from the top of the frame, and the hopper can be raised or lowered to suit the various tiers of retorts by means of gearing worked by the same motor that propels the machine. The hopper on each machine for carrying the supply of coal for the charging is provided with a feeder box controlled by a hand wheel for regulating the amount of the charge. The charger which enters the retort with the coal is carried in a frame suspended below the hopper, and is driven in and out of the retort by a compressed air cylinder, rack and pinion, chain drums and chains. This

charger, which is a very important part of the apparatus, has all the movements for charging a retort properly, the mechanism being protected from the coal dust by a cover. The charger consists of a scoop and a carriage containing the mechanism for emptying the coal out of the scoop and righting it for a fresh supply. It is also arranged that the scoop shall enter the retort twice in order to make a complete charge, first turning over in one direction and next in the other, thus throwing the coal toward the right and left hand sides of the retort respectively. The scoop is entirely suspended by its carriage, and does not at any time rest on the retort.

The drawing machines are fitted with traveling gear and hoisting gear for raising and lowering the rake bar frame, carrying the rake bar and head to the several tiers of retorts. It is fitted with compressed air and controlling cylinders, rack and pinion, chain drums and chains for driving the rake head in and out of the retort. Both the charging and drawing machines are worked by compressed air, supplied by an air compressor fixed in a building at the end of the coal stores. This compressor has many special features for compressing air with the smallest possible expenditure of steam. The cylinders are steam jacketed and fitted with expansion valves, with variable cut-off, adjustable by hand from the outside. All the bearings are of extra size, to minimize wear and tear and repairs, under the conditions for running day and night. The air cylinders are of two sizes, and do the work of compression to 60 lb. per square inch in two stages; and between the cylinders there is a tubular cooler to take out the heat developed by the compression in the low-pressure cylinder. In addition to this, each cylinder is provided with a jacket filled with water for cooling. The suction and delivery valves have a positive action controlled by cams on revolving shafts, so that the valves may have large areas and wide openings to prevent wire drawing and friction of the air and yet be well under control to prevent detrimental shocks.

Fig. 1 shows a general view of this compressor, which has been arranged of sufficient size to drive six pairs of the machines, and a perspective view of the air cylinders with their valve mechanism is shown Fig. 2. Having perceived that no defect has had such a prejudicial effect upon the working of compressors as the throttling of the inflow and outflow passages due to insufficient valve area, and that it was hopeless to expect better results from automatic acting valves of any description, it was decided to arrange them with a positive action, and thus to control both the closing and opening periods of their operation. This object is achieved by Messrs. West and Jenkins' patent arrangement in the following way: Springs are arranged upon the valve stems in such a manner that the weaker or opening spring has a tendency to open the valve, while the stronger or closing spring tends to close it. The latter spring is raised and released by means of levers worked by revolving cams. For instance, the operation of a suction valve is as follows: During the latter part of a given compression stroke, the cam is arranged to depress one end of the lever and compress the closing spring, thus leaving the valve closed under the pressure existing in the cylinder, but having a tendency—given by the opening spring—to open. As soon as the piston recedes, the pressure above the valve is reduced, and the opening spring immediately lifts it wide open, the amount of the lift being such as to give a free area equal to the area of the seating. The cam then keeps the closing spring compressed during the greater part of the suction stroke, and the releasing of the spring only begins when the piston is two or three inches from the end of its stroke; the springs then gradually force the valve shut as fast as the shape of the cams will allow, the valves thus closing very slowly, and all hammering is entirely prevented. The motor, which is shown in Fig. 3, consists of a double cylinder engine boxed in so that the whole of the working parts run in an oil bath, the reversing being done by Joy's patent valve gear.

After the air is compressed it is delivered into and is stored in two cylindrical receivers placed in the coal stores. These receivers are provided with all the necessary inlet and outlet connections and safety valves. The air is conveyed from the receivers by iron pipes to the hose drum fitted to the girders carrying the overhead coal hoppers for supplying the charging machine with coal.

There is a large hose drum complete with all fittings for each of the charging and drawing machines, a long length of flexible hose being attached to each of these drums at one end, and at the other end to the machine which is supplied from it. Each drum is provided with a hollow shaft through which the air is supplied, and by an arrangement of gun-metal swivel joints, the air is supplied to the hose on the drums while they revolve. On each of the hose-drum shafts a chain drum is keyed; a chain attached to this leads over pulleys fixed in the retort house roof, having weights at the other end, which rise and fall as the hose is automatically paid out and in by the machines. The hose leading from the drums of the machine is specially constructed for conveying air, and is supported at intervals by suspending brackets and rollers, so that the strain on the hose is very light.

As regards the financial results of the system, it may be interesting to state that, prior to the use of the machinery, 100 men were employed per twenty-four hours in the retort house, and since that time the total number is 67, a reduction of 33. In both cases the number given includes every kind of labor required in the retort house and coal store—stokers, coalmen, cokemen, and furnacemen in one case, and the machine attendants, engine drivers, stokers, cokemen, and furnacemen in the other. The men dispensed with are principally the high paid stokers who work close up to the hot retorts; and, according to Mr. Geo. Livesey's evidence before the Royal Commission on labor, the proportion of this particular class dispensed with is no less than 61 per cent. of the number employed before the introduction of quantities of similar machinery by the same makers at the South Metropolitan Gas Company's works in London. The total cost by hand labor amounted to 2*s.* 5*d.* per ton of coal carbonized, and by machinery the cost of labor is 11¼*d.* per ton, to which must be added the ascertained cost of fuel, oil, waste, wear and tear, depreciation, and interest on capital outlay, amounting to 3*d.* per ton, or a gross total of 1*s.* 2¼*d.* per ton, leaving a net saving in favor of the machine work of 1*s.* 2¾*d.* per ton. The amount of coal carbonized per annum is about 105,000 tons.

ARTIFICIAL FUEL GAS.

By HENRY WURTZ, Ph.D.

WRITERS in general literature often urge that man—to gain his ends and to discover the best means of their attainment—should ever aim to follow and imitate Nature; searching out first what she does and how she does it. This precept, plausible as it is, very rarely has any practical application to the great arts of civilization, in which man must continually strive to advance, to better himself, if possible, and certainly his race.

The impersonality called Nature works and has worked under conditions usually unattainable by man—a remark that applies to her modes of elaboration of the most valuable substances she presents to us. She has had materials, time and energy without limit. For man all these are narrowly limited. The valuable products of Nature referred to have almost all been accumulated with extreme slowness by processes impossible in human practice.

This statement applies eminently to combustible gas, now so great and so growing a factor in the affairs of civilized life. Nature presents to us almost pure gaseous *methane* (marsh gas, fire damp, or "natural gas"), in quantities incalculable; while to man the preparation of this special gas artificially in isolated form is so difficult that as yet it is but a curiosity of the laboratory. Nevertheless, as it often happens with popular fallacies that there is some tincture of truth in them, there are here hints of value to man in Nature's mode of storage of her fire gas under great *pressure*.

Man, unable to get methane in quantity by any artifice as yet discovered, has been compelled to diverge widely in this field from Nature's track. To find a cheap, incondensable, smokeless, gaseous combustible, as a vehicle of heat energy, he has been obliged to resort to what is popularly known as "water gas." This consists practically in a solution of carbon by high heat in steam. It ought to be called *steam-carbon* gas. The name water gas has done mischief by imbuing the minds of many with the fallacy that water could be converted *per se* into a combustible. In so-called water gas there is no water, as such. It is partly composed of the elementary basis of water, *hydrogen*, the rest being mainly *carbon monoxide* (carbonic oxide), the same gas that is often seen burning with a bluish flame over an anthracite fire, sometimes called "stove gas." It often escapes from open stoves, always injuriously, and sometimes with fatal effects. It contains all the oxygen of the steam, but can burn with just as much more oxygen, to form carbon dioxide (carbonic acid). By weight it contains, roundly, 3 of carbon to 4 of oxygen; or, in 100 lb., 43 carbon and 57 oxygen. When it burns, that is, doubles its dose of oxygen, the carbon dioxide formed contains 3 of carbon to 8 of oxygen; therefore, in 100 lb., 27·3 carbon and 72·7 oxygen. Carbon dioxide is well known as the gas of fermentation, contained in beer, champagne, effervescent "mineral waters," etc. It also can suffocate or asphyxiate (as often in wells and caves), and is rated by many toxicologists as a narcotic poison, but is doubtless less dangerous than carbon monoxide. Curiously, in the stomach it is even beneficial, being merely a mild sedative.

Neither of the main constituents of water gas (hydrogen and carbon monoxide) are found at all plentifully in nature, and have certainly never been stored up for man, like methane.

If steam be passed into highly heated *pure* carbon, 9 lb. of steam with 6 lb. of carbon form 1 lb. of hydrogen and 14 lb. of carbon monoxide. By a wonderful chemical law, the resulting water gas contains exactly *equal volumes* of the two mixed gases—carbonic oxide being exactly fourteen times as heavy as hydrogen—the former (sp. grav. = 0·97) having almost the weight of air, while air is 14·43 times the weight of hydrogen (sp. grav. = 0·0693).

$$\text{Thus: } \frac{1}{0{\cdot}0693} = 14{\cdot}43\text{; and } \frac{0{\cdot}97}{0{\cdot}0693} = 14{\cdot}0.$$

This simple relation is, however, *never found* in practice. Deficiency of heat leads to the formation of some carbon dioxide with some of the oxygen of the water; and there are always present, in both anthracite and coke, some iron and sulphur, both of which take up oxygen and set free hydrogen. There is also a small percentage of hydrogen, contained in the coal or coke, set free. Through these joint influences, the hydrogen always predominates in practice over the carbonic oxide, sometimes 15 per cent. or more in volume. It is important to note this, for it is singular how many writers have committed the oversight of assigning to water gas, as practically made from coal and steam, the *theoretical* equality of volume between the two components. Even so high an authority as Dr. Bunte, the eminent German gas expert, seems to have sanctioned this error. As another example, W. J. Taylor, in an elaborate communication to the Institute of Mining Engineers in 1890, introduces the same inaccuracy more than once, and, himself misled thereby, ciphers out thence the weight of 1,000 cubic feet of what he gives as a *typical* water gas = 45·6 lb., quite 10 lb. too high, thus vitiating largely his conclusions. He also states that 1,000 ft. consume in production 48 lb. of anthracite, some 27 per cent. too high. Besides its two main components, water gas always contains a small percentage of marsh gas (methane), which is by no means unimportant, and a little nitrogen, which is of trifling importance.

The history, during a century past, of the art of producing water gas can occupy but a very limited space. There appear first two of what may be called traditions. One carries it back just a century, to Lavoisier, in 1793, the year before he was murderously done to death by the guillotine. When he asked, on his way to execution (in vain) for a day's respite, to enable him to record an invention valuable to his fellow men, he is thought by some to have meant water gas. The other tradition goes back to Felice Fontana, 1780, a year previous to the first synthetical discovery of the composition of water by Cavendish and others. It is probably only fanciful. The first actual record of the passage of steam into incandescent carbon to make gas is in the British patent to John Holt Ibbetson, seventy years since, in 1824. Many have thought that one of the most important features of our present water gas method, that of alternation of air and steam, is implied in the British patent of 1853 to the Kirkmans; but careful examination shows that, if implied, it is too vaguely specified to be satisfactory. The Kirkman patent does, however, plainly cover two important features—one the making of the steam by the waste gases from the air blast, the other the subsequent passage of these same waste gases through metal tubes, around which the air passes that is blown in. This is a kind of recuperator anticipating that of Siemens. It is not till the French patent of 1860 to Fages that we find distinctly the method of alternating blasts of air and steam specified, as now universally practiced. In the mean time, so-called "producer gas," or air-steam gas, as it is best called, had been invented by another Frenchman, George Michiels, then in the island of Guadeloupe. His patents, both American and British (the latter as a communication to John Constable), are dated on the same day, May 24, 1845.

The further combination of "checker-work" regenerators—as introduced in 1856 into metallurgical furnaces by Siemens—originated in America about 1874, simultaneously with T. C. S. Lowe and Myron H. Strong (deceased). This feature was made to perform quite different functions, however, by these two inventors. The aim of Strong was to make water gas, or *fuel* gas pure and simple, for heat and power, and he used his checker-work to carry back with the steam blast the heat generated by burning in it the gases from the air blast. Lowe aimed at a compound *illuminating* gas—introducing oil or naphtha into his hot water gas, and passing the mixture through the checker-work, previously made incandescent by burning through it, with more air, the gases from the air blast. The object of this was to "fix," or permanently gasify, the oil vapors. It is this latter method that has already, in twenty years, come so extensively into use and spread over this continent, for making illuminating gas. Few inventions have had a career so immense and so rapid; though obliged to encounter the competition, or rather (what was worse) the prejudices, of opulent "vested interests," already in secure possession of the whole field, banded together to resist all innovation from outside, and with whom a novel experiment, on the part of an employe, was usually equivalent to dismissal. The general principle was here exemplified, that leading inventions in special arts scarce ever originate among the specialists engaged in operating such arts; but are commonly forced in from outside by men who, not being specialists, are not held in a rut, but are at liberty to seek out and explore better paths. On this subject controversies arose during the decade from 1875 to 1885, full of the most extraordinary bitterness, acrimony, misrepresentation and even persecution—not much surpassed in the religious wars we read of in history. Most of this must be passed over here. In 1880, the present writer made an extended communication to the Institute of Mining Engineers on water gas, in which all the accusations brought against it were rebutted, and the opposition of the gas profession thereafter greatly enfeebled.

Although, as will be apparent, the methods and the results of Strong and Lowe differed essentially, yet, as their combinations of apparatus were similar, they were at once plunged in the Slough of Despond called an "interference." Had not moderate counsels prevailed within two or three years, this might have proved the finality. The present writer, who was called in professionally by parties interested with both inventors, urged without ceasing a policy of compromise, which ultimately prevailed.

The accusations brought against the use of water gas alone or in combination with illuminants, which originated among the gas profession, but were adopted and advocated by most of the men of science of this country, and by the scientific journals generally, may be stated as follows: By the laws of combustion and dissociation water gas must needs cost as much to get it as can be got from it; that is, to *unburn* water must take as much heat as the resulting hydrogen can evolve in burning again; water gas is loaded with one of the most *terrible and fatal of poisons;* its odor was not such as would alarm consumers, and hence gas deaths and explosions would quickly decimate and desolate the land; it was so dense that it would not pass the mains and service pipes, and would stratify on the floors of rooms; it was terribly explosive and incendiary; it was easily condensed; it required new and special burners; its manufacture was dependent on anthracite, and, for an illuminant, on oil, local and precarious materials; no coke was made; the tar formed was worthless; it was impossible to purify out the sulphur from it; it involved danger from storage of oil at the works, and so on. Each of these arguments was found in practice to be incorrect, or without weight. That which appeared the most serious of all, and which even to this day is insisted on largely by some men of science, is that of the very poisonous nature of carbonic oxide. It was claimed that more than 10 per cent. of this component should taboo a gas altogether for domestic uses, and State laws were even passed to enforce this restriction. These were soon repealed; in Massachusetts the very man who originated the law petitioning for its repeal. Many of the men of science who fought, and still fight, against water gas, ignore what they should know well, that certain other illuminating gases that have been and still are largely in use contain much more than 10 per cent. of the "deadly poison," thus: Gas from Ince Hall cannel, 10 per cent.; from Lesmahago cannel, 15 per cent.; animal oil gas, 15½ per cent.; resin gas, 19 per cent.; peat gas, 20 per cent.; and wood gases from 26 to 41 per cent. At the present time the vast majority of the American gas profession have bravely overcome these prejudices, and now more than half, some maintain full two-thirds, of the illuminating gas on this continent is made by the Lowe process or modifications thereof.

The Lowe process was launched at a most fortunate period, and enjoyed great advantages to compensate for the virulent opposition met from several sources, as already related. It was an improvement in the production of an article of human consumption and necessity, having already a large *established market*. The public required little or no *educating* into it, as it does

in the case of most novel inventions. It had, indeed, long demanded improvements in this field, and recognized them at sight. Holders and mains, etc., for storage and distribution, were already at hand. Oil was abundant and increasingly so. Intelligent and disinterested men rarely paid much attention to the accusations above mentioned, knowing, as most men now know, that in most arts the men who should be the first to seek for improvements are often the last to admit or even consider them, because they *interfere with established routine.* But, above all, it was found in time by the manufacturers themselves that one great virtue of the Lowe process was its *rapidity;* which is many times as great as the old methods with gas coals and retorts. Even those of the gas profession who could not and do not yet abandon their *religious* reverence for the time-honored gas retort now want a water gas generator in their works, as a supplementary provision for emergencies, when their gas holders have sunk alarmingly low. A few hours' work then with the generator lifts them to the top of the framework again. Then, as the retorts burn out, they are irreverently cast aside, and the generator ultimately rules supreme. The Strong process, though the writer believes it destined ultimately to even a greater career than that of Lowe, has had no such advantages. Natural gas has, it is true, educated such communities as are fortunate enough to be within its boundaries of distribution into the immense value of gaseous fuel; but doubtless a vast majority of the people of this continent have never had such "object lessons," and have never even seen natural gas burn. There is yet no *market* ready made anywhere for fuel gas, and, above all, no storage or distribution systems everywhere available, as in the case of the Lowe gas. Our college professors have not yet overcome their horror of carbonic oxide, and still teach it to their pupils. All men of science do not adhere, however, to these prejudices. Two paragraphs may here be cited, to contrast the animus formerly prevalent with that of one of the great chemists of the present age, or indeed of any age. The first is from the Boston *Journal of Chemistry,* which was in its day a most estimable and reliable journal in general. June 1, 1881, the following editorial passage is found in it:

"Frauds of a higher type in the line of invention are often brought to notice, and just now many of this kind are prominent. To this class belong the 'Keely motor,' the 'water gas' delusions, and so on. With the 'respectable' fallacies we are also inclined to class Edison's scheme of electric lighting by incandescence"!

The "fallacies" of the writer of this need no explanatory remarks at the present day.

The second passage is from Mendeleeff's great work. "The Principles of Chemistry," published just ten years later than the above, in 1891 by Longmans, Green & Co., London. On page 390, vol. 1, we find as follows, on water gas:

After stating that "it is available not only for domestic and industrial uses, but also for gas motors and for lighting" (instancing various forms of incandescent gas lights, from Crookshanks and Gillard down to Fahnehjelm and Von Welsbach; also compound enriched gases, and the uses of naphthalene, benzole, etc., with it), he goes on to say:

"As water gas, possessing these properties, may be

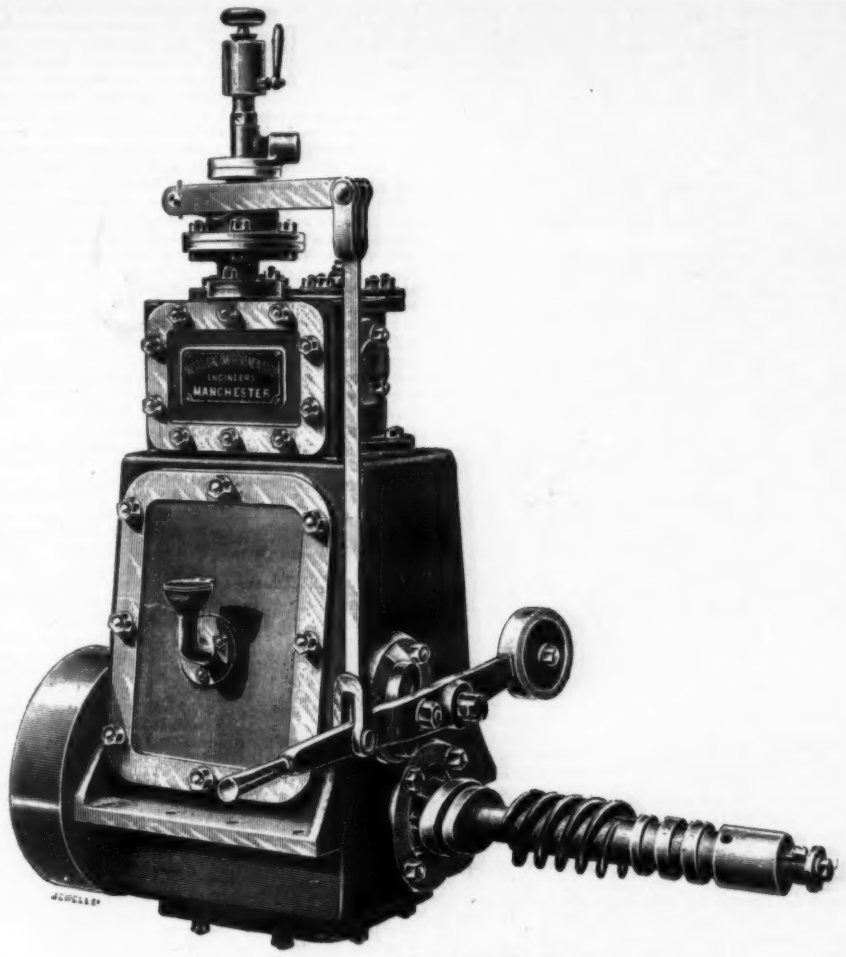


FIG. 3.—THE MOTOR.

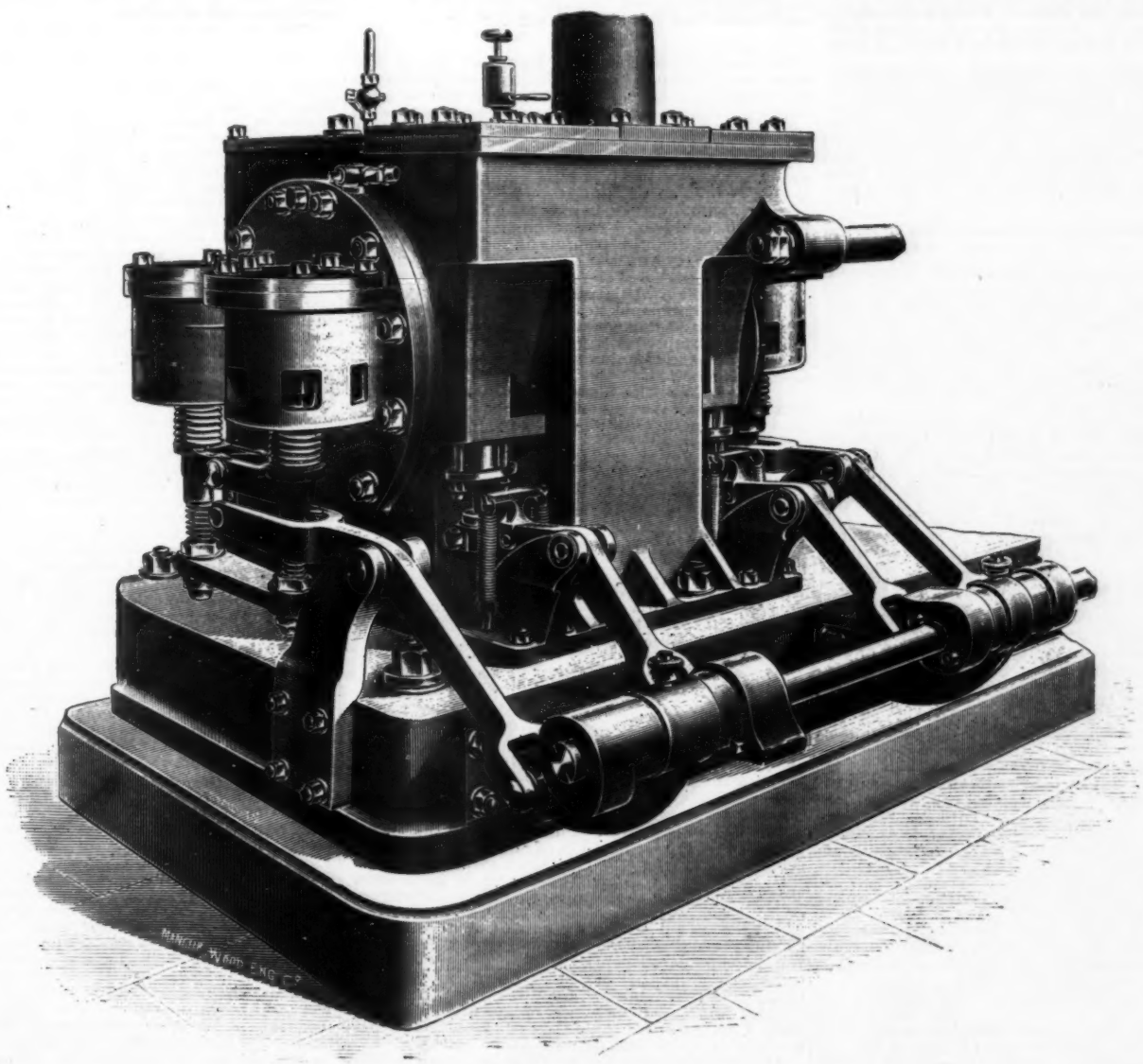


FIG. 2.—VALVE GEAR OF COMPRESSOR, MANCHESTER GAS WORKS.

prepared at central works and conveyed in pipes to the consumers, may be produced from any kind of fuel, and ought to be much cheaper than ordinary gas (he means, of course, gas from gas coal), it may actually be considered that in the course of time (when practice shall have determined the best and cheapest way to prepare it) it will not only supplant ordinary gas, but will, with advantage, everywhere replace the ordinary forms of fuel, which in many respects are inconvenient. At present its consumption spreads principally for lighting purposes, and for use in gas engines, instead of ordinary illuminating gas." It will be observed that Mendeleeff does not mingle with the carbonic oxide imbroglio.

The writer has now arrived at the stage of our subject at which to introduce his proposed plans of utilizing pure water gas, so as to realize the expectations he has himself already set forth, and which, as has been seen, are entertained also by chemists of such rank as the illustrious Mendeleeff. Gas for fuel and power purposes, when once fairly introduced into public use and favor, will rapidly create for itself a market surpassing in magnitude that for illuminating gas to an enormous extent. Such market must indeed grow to such a magnitude that the ordinary modes of storage and distribution will be wholly inadequate, and new engineering problems will at once arise. The primary solution of this difficulty is set forth in an early paragraph of this essay, namely, storage and distribution in a high state of compression, just as nature supplies us with her rock fuel gas. The power for compression will be simply obtainable from a portion of the gas itself. Probably the most impressive way to make clear the advantages of this system of supplying a vehicle of power, heat, light and energy generally, will be to compare it in some detail with the other modes, in use or proposed, for conveying energy. These may be enumerated as follows:

1. Steam distribution.
2. Electrical distribution.
3. Compressed air distribution.
4. Natural gas distribution.
5. Illuminating gas distribution.
6. Producer gas distribution.
7. (And finally) Water gas distribution.

1. *Steam.*—The serving out to the public of this, as a medium of heat and power, is exemplified on a great scale, under the eyes of all, here in the American metropolis. It makes little progress, however, outside the "business" sections of the city, where the demand for operating passenger elevators and for heating huge office buildings is so great. It has as yet scarcely passed at all into any domestic use; and, for reasons, some of which are explained further on, must always be crowded out for such uses by gas, even if the latter cost more, which will not be the case with water gas. The cost of distribution, and of the plant, therefore, must always be far greater than with gas, under equal pressures, because not only must leakage, that is, escape of the material itself, be provided against, but also escape of the heat, which constitutes an additional loss, is constant and inevitable, and must be even greater than that from large leakages. *Distance* is here, therefore, a factor of leading importance.

A direct comparison between steam and compressed water gas, in their relative capabilities as vehicles of heating power, may be interesting. For simplicity, we may assume steam of ten atmospheres or 147 lb. to the square inch, and that both agents are to be applied to heat water from the freezing to the boiling point, that is, through 180° F. Then 100 cu. ft. of saturated steam of 147 lb. pressure, which weighs 32·9 lb., will so heat

$$\frac{32\cdot9 \times 1{,}191}{180}$$

, or closely 218 lb. of water; while 100 cu. ft. of water gas, of the above composition, compressed from 1,000 ft. to 147 lb. tension per square inch, will weigh 33·38 lb., and will evolve, on burning, 313,000°. Thus it can heat through 180° about 1,739 lb. of water, or almost *eight times as much* as with the steam. It will, moreover, remain in the reservoir or main containing it, if gas tight, indefinitely without loss of energy; whereas the energy of the steam cannot long be held or confined by any known means.

2. *Electricity.*—This system of distributing energy is now being worked out at monstrous expense in all countries, and has a great destiny before it. Insulation is the main consideration, and, unlike steam, distance is of minor importance. The trouble, so far, is the lack of a successful *reservoir* system for electricity. Storage batteries are expensive, bulky, heavy, and leaky, and, thus far, adaptable only to special limited kinds of work. The best system of the future is likely to arise out of the use for lighting and other electrical purposes of small isolated dynamos, operated by gas engines fed from water gas compressed in mains, or even in portable reservoirs. Such gas engines are, of course, readily adaptable to all other household uses, as pumping, ventilation, sewing, washing, and sweeping machines, elevators, and so on.

3. *Compressed Air.*—This has, over steam and electricity (though not over gas), the advantage that the distribution system constitutes an extension of the storage reservoir system, and, with good construction, without liability to waste. In this case, a distinct advantage is that, in case of leakage inside a building, though loss may fall on the producer, nothing detrimental or dangerous to the consumer can escape. The cold produced by expansion, in case of extensive usage, must often cause inconvenince. It is stated that in Paris this system has been employed satisfactorily on a considerable scale. But to this system the decisive objection applies that out of compressed air little or nothing is to be had more than the mechanical power that has been put into it. For domestic use it has no important value except for small power purposes. Compressed gas has clearly enormous advantages over it in the number and variety of household requirements it can be made to fulfill.

4. *Natural Gas.*—This being a local product, has little direct bearing on our topic. But the remark should here be made that were it possible to get marsh gas (methane), the characteristic product of the gas wells, cheaply, by artificial means, it would be far less suitable for domestic employment than water gas, by reason of its exceptionally great *explosive* energy, due to the great rapidity of propagation of flame throughout its mixtures with air. In this respect, the behavior of carbonic oxide, the characteristic component of water gas, is peculiar and so important that it ought to be clearly set forth. Flame is propagated through its mixtures with air with such comparative slowness that there is sometimes difficulty in obtaining what can be called an explosion when wanted. The passage of such a flame through a glass tube may be followed by the eye. Men accidentally immersed in such an exploding atmosphere in water gas works have escaped with little or no damage. Such an explosion, as the writer has himself seen, does not even scorch and char wood, whereas that of any gas based (like that from gas coal) largely on methane always blackens, and often inflames, wood, as in the case of firedamp in mines. Moreover, in mine explosions the flame often reaches the lungs or air passages of men with fatal after effects.

5. *Illuminating Gases.*—The distribution of these under small pressures all are familiar with; but not under the aspect that we have now to deal with. Under pressure it must fail, and probably has already failed, experimentally, in New York City. In the northern part of this city, above Central Park (and elsewhere), the principal streets were underlaid a number of years ago with a system of small screw-jointed steel piping, like that employed for natural gas. This was said to have been laid by the Standard Gas Light Company, presumably for the distribution of illuminating gas under pressure. The history of this experiment the writer does not know, but if for illuminating gas, it doubtless failed through the condensation of the illuminant hydrocarbons. This must always prove a decisive objection in such a case.

6. *Producer Gas.*—This mixture of gases is formed by action of air, or, more commonly, of mixed air and steam, on anthracite or soft coal, *in excess*, the object being to burn the carbon only to carbonic oxide, instead of carbonic acid, and is of extensive employment in metallurgical work. The following may be cited as the composition of an average air-steam producer gas, made from soft caking coals, and of the type made by the Siemens, Wilson and other producers in extensive use.

	Volumes in 100	Pounds in 100
Hydrogen	12·1	0·96
Carbon monoxide	23·5	26·16
Methane	6·3	11·04
Carbon dioxide	4·7	2·99
Nitrogen	51·4	57·42
Moisture	2·0	1·43
	100·0	100·00

Specific gravity at 60° F. = 0·87.
Total heating power per lb. = 2,438° F.
Total heating power per cubic foot = 102° F.
Weight of 1,000 feet at 60° F. = 66·44 lb.

The total volume of such gas from one ton of coal varies from 120,000 to 150,000 cubic feet, or 2½ to 3 times the volume of water gas obtainable. It will be seen, however, from the sum of the lower three constituents that nearly 60 per cent. of the volume and about 62 per cent. of the weight is useless and inert matter.

To economical distribution, either with or without pressure, this is a decisive obstacle. It is evident that to convey the same amount of energy, the distribution system would have to be correspondingly larger, at large additional cost; a remark applicable also to the storage plant and the compressing apparatus. This producer gas is sometimes hard to kindle without being first heated, and the cold produced by expansion from compression would prevent kindling altogether. Moreover, a dangerous feature, in all domestic use, would be that its flame is very *easily blown out*. Producer gas is adapted only for use at the point of production, while still retaining as much as possible of the heat of production.

7. *Water Gas.*—The mean of two analyses, by the writer, of the water gas of the Strong apparatus at Mount Vernon, in 1880, was as follows (purified):

	Volumes in 100.	Pounds in 100.
Hydrogen	50·15	7·04
Carbon monoxide	41·25	80·76
Methane	5·56	6·22
Nitrogen	3·04	5·98

Specific gravity at 60° F. = 0·497.
Total heating power per lb. = 9,322° F.
Total heating power per cubic foot = 313° F.
Weight of 1,000 cubic feet at 60° F. = 33·38 lb.

The estimate of Strong himself for the cost of putting such gas (unpurified) into the holders was 8 cents per 1,000 ft. As determined by the writer, 10 cents per 1,000 should cover everything, inclusive of purification. The cost of distribution under pressure could not be determined at present. An engineer's estimate would be required. One thousand feet of the gas was produced from less than 38 lb. of lump anthracite (with some culm), or over 50,000 ft. from a short ton.

B. Loomis, in a communication made in October, 1890, to the Institute of Mining Engineers, gave figures of *his* actual work in making water gas with coal at $3 per ton as ten cents per thousand. His make from 25 short tons of coal averaged but 40,000 ft. per ton; but he claimed to get in addition $40 worth of producer gas from the 25 tons. Loomis' regenerator chambers do not appear, from his cuts, to contain checker work, and may not recuperate fully. He valued his water gas at 340° F. per foot, but gave no analysis by which such figure could be verified.

Another analysis of simple water gas, made in 1878, at the works of the Municipal Gas Light Company, in New York City, by the writer, may be cited also.

Hydrogen	49·32
Carbon monoxide	37·97
Methane	7·65
Carbon dioxide	0·14
Nitrogen	4·79
Oxygen	0·13
	100·00

In such gas there is nothing left, after purification, of an *odorous* character; hence it will be necessary, to qualify it for distribution, to add some volatile hydrocarbon or other odorous compound, in minute quantity. Oil of turpentine or camphor may be suitable for this purpose, but objection may be made to these, through apprehension that the familiarity of their odors might prevent some from taking alarm in the case of leakage. Rudolph Wagner suggested some years ago the use for this purpose of *nitrobenzole*, a compound which has an extremely powerful odor, like the essential oil of bitter almonds. This might answer; but there are many essential oils of extremely characteristic and powerful odors, not in common use, which could be cheaply prepared for this purpose. Doubtless the more *repulsive* the odor, the better it would serve the purpose of an alarm.

The introduction of compressed fuel gas into use in cities would lead in time to great changes in human affairs. Vehicles would no doubt be built of all kinds, fitted with gas engines and reservoirs, the latter being charged at any time in a moment from a gas main. Charging stations could be established, if necessary, at all the important crossings of streets. Street cars would be moved in this way. The dream of sanitarians of banishment of horses and stables altogether from cities could be realized, and clean streets would then become a possibility. Invalids would then flee to cities, instead of fleeing from them. Smoke and ashes in cities would become traditions of the past. Quite possibly dust also. Even city noises might be largely abolished. Suburban residences throughout great areas around cities could have reservoirs supplied through pipes of very small caliber which, on a large scale, could be made and installed almost as cheaply as electric wires. The works manufacturing the gas need not be within the city, but may be at a considerable distance therefrom. One large works could supply several neighboring towns. The mechanical devices, which would be simple, for reducing the pressure, would, of course, be located *outside* the buildings supplied, as well as all local reservoirs. The meters, however, would, as now, be placed inside.

Ultimately, all lines of traffic, travel and transportation by land and water, including railways and common highways, will be provided with gas pipes, with reservoirs at suitable points, for charging vehicles, locomotives, vessels, etc., with the compressed gas; or for exchanging loaded reservoirs for exhausted ones, which could be accomplished almost in a moment. These things some may look upon as visionary, but the reader may be assured that they are substantial certainties of the future. They might be supplemented largely by additional suggestions, quite as sure to be realized in time.

OIL IN COLORADO AND WYOMING.

THE producing petroleum district of the Rocky Mountain region is at present included in the district known as the Florence oil fields, in the valley of the Arkansas River, west of Pueblo. These oil deposits, while they have been producing for many years, are said by experts to be very different in their character from those of Pennsylvania and Ohio, for while petroleum in these States is invariably in large quantities in a stratum of sand below the shale, in Florence the oil is found in the shale strata itself; hence doubts are expressed by experienced oil experts as to the permanency of the supply. They do not hesitate, however, to assert that the oil exists in inexhaustible supply all through the Rocky Mountain sections of Colorado and Wyoming. The oil belt is known to extend from Central Wyoming south beneath the western portion of Colorado as far as the Grand Valley near Grand Junction. Even in the immediate vicinity of Denver, where experimental wells have been sunk to a depth of 2,800 feet, both oil and gas have been found, and those interested in these explorations express confidence in their ability to develop both oil and gas supplies within 10 miles of Denver. Their operations are confined to land located about 9 miles north of Denver. So, while the present productive oil field is limited to Florence, Col., and Casper, Wyo., the area of petroleum deposits is immense in its extent.

The output of the petroleum wells at Florence is about 2,000 barrels of crude oil daily, which produces from 36 to 40 per cent. of refined oil. The oil is pumped from depths varying from 1,400 to 2,100 feet and finds its way into storage tanks which have a combined capacity of 300,000 barrels. These wells have been pumping more or less daily for about eight years, and show no diminution in the force of the flow or change in the character of the oil. The Florence petroleum lands are owned by four large companies, as follows: The United Oil Company, capital $2 000.000; the Rocky Mountain Oil Company, capital $1,000,000; the Florence Oil Company, capital in excess of $500,000; and the Triumph, which is heavily capitalized. A total of about $4,000,000 for the Florence oil companies.

Fifty wells are now producing oil, and their combined product is estimated from 2,000 to 2,500 barrels daily. While only 50 wells are producing oil at this time, about 140 snafts have been sunk to the oil deposits, as follows: United, 73; Rocky Mountain, 35; Florence, 26; Triumph, 6.

Crude oil is refined in several large refineries, located at Florence and Overton, a village not far distant from the wells. The Overton refinery belongs to the Rocky Mountain Oil Company and pipes its crude oil through a 4 inch pipe from Florence, and has a capacity of 5,000 barrels a day. During the year 1893 the Florence Oil Company completed its second refinery at a cost of $75,000, with a capacity of 1,000 barrels a day. It will soon be in operation. The United Oil Company has made some costly additions to its refining machinery for the manufacture of fireproof oils for use in railroad cars, steamboats, etc. While no very extensive developments have been made in the way of output and increased number of wells during 1893, the

improvements made in the way of new refineries and improved machinery have been both costly and substantial the United Oil Company making an investment during the year in one instance amounting to $100,000.

Colorado's annual oil contribution to the wealth of the West amounts to at least $1,000,000 cash, derived from the sale of illuminating oil, machinery lubricants, tar for fuel, candles, axle grease and coke. About 300 men are furnished steady employment in the various departments connected with the oil industry, and the monthly pay roll is not less than $15,000. It is estimated that the outlay for labor for the year will not fall short of $180,000.

Separated from generalization and condensed into facts and figures, the progress of petroleum and gas development in Colorado and Wyoming during the past year may be summarized as follows: New oil wells, 12; new refineries, 2; increased output, daily, 500 barrels; number of men employed, 300; men employed in Wyoming, 50; monthly pay roll (Colorado), $15,000; annual output of oil in cash, $1,000,000; present daily output of oil, 2,000 barrels; natural gas discovered at Grand Junction, Col.

VOSPER'S OIL ENGINE.

THE 16 brake horse power oil engine made by Messrs. Vosper & Co., of Portsmouth, for driving launches, illustrated below, from *Engineering*, has four cylinders, and receives two impulses every revolution. To make the engine easier to start, three of the cylinders are thrown out of compression, and the engine is started with a single cylinder. As soon as the one cylinder causes an impulse, the others are thrown into gear. Another advantage of the four cylinders is that by shutting the oil off from one, the speed of the engine can be reduced about forty revolutions. This is a great convenience in oil engines. The engine is fitted with two lamps, one to each pair of cylinders, each lamp heating its own vaporizer, D, and ignition tube, I. The air is heated also by the same means by passing through a hollow cylinder, E, forming the casing for the lamp. The supply of oil is regulated by the size of the grooves in the reciprocating spindles, worked by the levers, M, but for various grades of oil the air can be regulated. The oil passes down the vaporizer, by the pipe, C, together with heated air, which passes through the pipe, F. The oil supply is pumped up from the main reservoir into two small tanks or receivers holding about one pint each, one to each engine. A very great improvement has been made by making these with glass sides, so that it can be seen at a glance that the oil supply is all right. J are the admission valves and G the exhaust valves, the latter being worked positively by means of cams deriving their motion from the crank shaft. The crank is incased, and works in oil. The reversing is done by a set of helical wheels, thrown in and out of gear by a friction clutch—a very neat arrangement, and answering well. The shaft, when going ahead, is coupled direct by means of the friction clutch, and it is only in going astern that the wheels have anything to do; and as they run in a bath of oil, the wear and tear and noise are very small. This engine was built for a steel yacht, 50 ft. over all by 9 ft. beam, lately launched for Mr. Harvey, of Nenagh, Ireland.

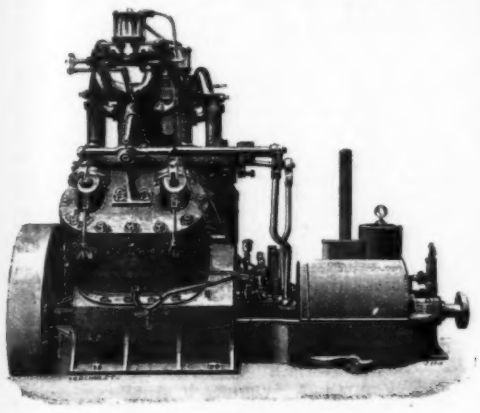


FIG. 1.

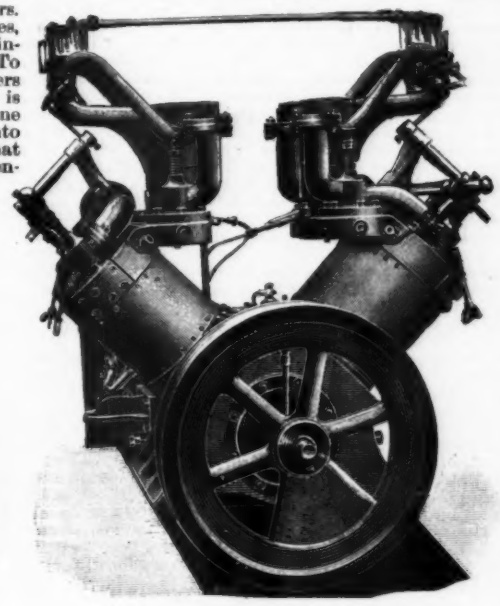


FIG. 2.

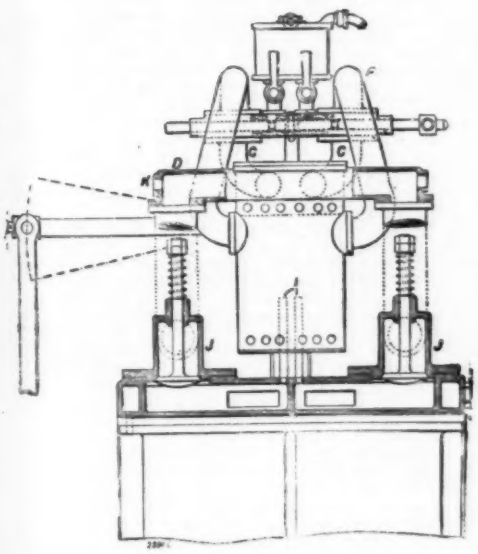


FIG. 3.

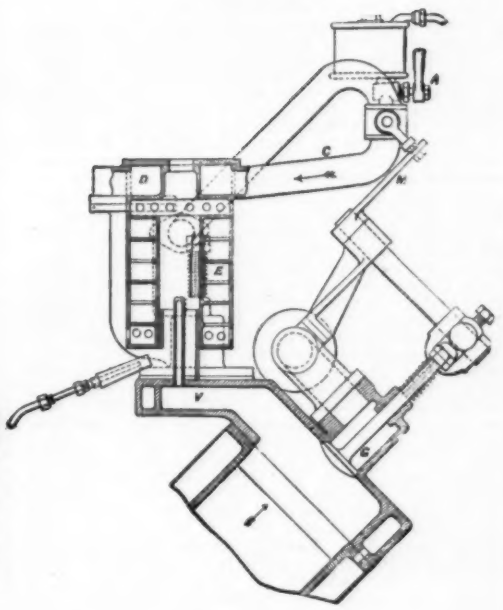


FIG. 4.

SIXTEEN HORSE POWER OIL ENGINE.

DEEP BORING NEAR FREIDSTADT, AUSTRIA.*

BEFORE entering on a detailed description of the particular boring to be described in this paper, it may not be out of place to say a few words on deep borings in general by way of introduction. The art of boring for minerals has been practiced by miners for centuries, but in past days the depths required and attained were shallow as compared with the present. The first bore holes were put down by hand labor, that is, by drawing up the rods and cutting tool, either directly with the aid of a rope passing over a pulley or indirectly by winding the rope round a winch. Subsequently steam power was applied to the winch, but the rope was still held by hand, and the action of the cutting tool in the bore hole was effected by raising it up a few feet and allowing the rods and the tools to drop with the force of their entire weight. The rods consisted of 1 in. or 1¼ in. square iron, and great difficulties were found in boring deep holes; first, by reason of the weight of the rods, and secondly, on account of the jar or vibration they sustained at each blow of the chisel. The limit of depth to which borings on this system could be carried was usually taken at 1,000 ft.

It is true that the Chinese have sunk bore holes to a depth of several thousand feet, by means of a cutting tool resembling the modern chisel, weighing with sliding piece 200 lb. to 300 lb., and attached to a rope passing over a pulley, which is pulled up by hand several feet and then allowed to drop. The time, however, required to sink these deep holes was reckoned not by years but by generations. In course of time, as it became necessary to sink to greater depths, improvements had to be introduced in the construction of the tools and the arrangements of the mechanical gear used to supply the motion to the cutting tool in the well or bore hole. Thus, the walking beam was applied, set in motion by a steam engine, and the "jars" and "free fall" tools were introduced to relieve the rods from the vibration consequent on the blow of the chisel on the bottom of the bore hole. Some such apparatus was necessary in order to prevent many accidents, which otherwise would occur in deep holes, through the breaking or bending of the rods or the falling in of the unprotected sides of the bore hole caused by the vibration of great lengths of iron rods. The introduction of these latter tools has been followed by a complete revolution in the art of boring, and has enabled depths of several thousand feet to be reached with a rapidity and economy not formerly possible. The deepest boring up to the present time, so far as the author is aware, is that of Schladebach, in Prussia, which is 5,736 ft. deep.

The so-called "jars" consist of two flat links of steel attached directly under the rods or rope, so that when the chisel strikes the bottom of the bore hole the upper link follows down until the stroke of the engine is completed, leaving the lower link and the tools alone to sustain the shock of the blow of the chisel. The links must be longer than the stroke of the engine beam, and in the Canadian rig they are generally 2 ft. 6 in. in length. The "jars" were first applied to boring in 1834 at a bore hole at Neusalz, in Germany, by the government engineer, Oeynhausen. This bore hole was sunk to a depth of 282 meters 51 c. (equal to 927 feet) with the usual tools, but by the application of the "jars" was subsequently carried down to a depth of 2,252 ft. The "jars" were soon replaced, on the continent of Europe, by the free-fall tool, where it was first applied by M. Kind, in 1844. The principle of this instrument consists of an arrangement by which the cutting tool is lifted with the upstroke of the walking beam, and then released by means of a suitable mechanism, allowed to drop, and give a blow in proportion to the weight of the tools and the length of the drop. In the Fabian and similar free-fall instruments, a rod to which the cutting tool is attached works in a tube or box. At the top of this rod is a pin, which by turning the rods slightly from the surface engages in a slot, and is thus raised by the upstroke of the beam. Then, generally by bringing the free end of the beam down on a block of wood, sufficient vibration is caused to disengage the rod in the box from the slot, and in combination with a turn of the rods by the driller the chisel falls freely to the bottom of the bore hole. This is the most simple contrivance, but sometimes the vibration is produced by bringing the end of the beam to which the tools are attached in contact with a properly fixed block of wood on the upstroke. The concussion, however, produced is considered by the advocates of this system of boring to be of great importance, as it limits the stroke, facilitates the turning of the beam, and liberates the free-fall tool. It must here be mentioned that a number of "free-fall" instruments have been invented to enable the cutting tools to be released without the aid of any concussion. It would hardly be within the scope of this paper to enumerate them in detail. Suffice it to refer to one or two of them. Thus Kind has a disk of sheet iron fixed on the top of the free-fall instrument, which is acted on by the column of water in the bore hole, and thus sets a click in motion which liberates the cutting tools. This arrangement implies the presence of a column of water in the bore hole. Again, Leon Dru depends, in one of his inventions, on the slight momentum acquired by the tools, below his apparatus, on the upstroke to loosen a catch moving on a joint, which holds the tools, and on the downstroke the rods act on this catch so as to free the tools, which then fall to the bottom of the well. The box containing the catch follows down, and the tools are again caught up and raised. In the continental boring apparatus the power is generally obtained by means of a single-acting steam cylinder applied directly at or near one end of the walking beam, the rods and tools being attached to the other end. The steam power is applied to raise the rods up and the downstroke is affected by gravity. In this system of boring iron rods are always used, and they are partly counterbalanced by weights attached to the end of the beam in order to reduce the work of the steam cylinder, and a second small engine is required for lowering and raising the rods, tools and sand pump in and out of the bore hole. The object of this paper is not to describe the various systems of boring in detail, but it has been considered advisable to allude to the free fall instrument as distinguished from the jars, one or the other being applied in nearly all the methods made use of in deep borings. There are several systems in which these tools are not required, as, for example, the diamond drill, the water pressure system, applicable to soft measures only, and Messrs. Mather and Platt's invention, by which the chisel is attached to a flat rope and falls with its full weight on the bottom of the bore hole, a fall which varies according to the size of the machine and the nature of the ground to be bored through from 2 ft. to 16 ft.

The experience of the author in boring deep wells for petroleum showed that the Canadian rig and tools, in which the jars are adopted, was preferable to any of the systems involving the use of the free-fall instrument, on account of the greater rapidity of boring attained by this system.

The Canadian method originated in the early development of the petroleum fields of Petrolia, Ontario, which followed shortly after the first oil well was put down near Titusville, Pennsylvania, in 1859. At that time the so-called wells or bore holes were sunk by hand, and in this operation iron rods have always been, and are to this day, generally used. It is probable that the early Canadian drillers adopted ash poles in lieu of iron, in order to reduce the weight, and subsequently, when steam engines were introduced as motive power, they selected the American drilling tools, and in so far the Canadian method of drilling may be described as a modification of the American, the only difference being that in the former ash poles are used and in the latter a rope to convey the necessary motion to the cutting tool or chisel at the bottom of the bore hole or well. In the American method the so-called "jars" or "slips," consisting of two flat links of steel, in place of the box and catch used in the free-fall system, have always been used.

One advantage of the jars, among others, lies in the continuous and rapid working of the apparatus. In good drilling ground it is not exceptional to run at the rate of 60 and even 70 strokes a minute, either with

* A paper read at a meeting of the Society of Engineers, Westminster, May 7, 1894, by R. Nelson Boyd.

wooden rods or ropes. The jars were adopted in America on the application of steam power in conjunction with the heavy tools necessary for drilling with a rope. In the United States the rope is generally made of hemp 1¼ in. diameter, and is kept taut by means of heavy weights, termed sinker bars, and these, together with the string of tools, make up a total weight of about one ton. This arrangement has been most successful in sinking deep wells in the oil regions of the United States. It is especially adapted to the stratification of the ground in Pennsylvania, where the beds lie at a gentle inclination and consist mostly of sandstone and slaty shales, which are easily bored through and yet sufficiently firm to stand without the necessity of casing or lining. The oil and gas wells of the United States attain a depth of over 3,000 ft., and are economically sunk by means of the rope system. In boring to a great depth in Pennsylvania, it has been found advisable to use a flat hemp rope instead of a round one. Steel ropes have been recently introduced, but have not been as yet adopted generally. In Canada, where the wooden poles are customary, the depth of the wells does not exceed about 500 ft., and as the ground is exceptionally easy for drilling, as much as 100 ft. can be sunk in a day.

In the Petrolia oilfield a good set of drillers reckon to finish a well, that is to a depth of 500 ft., within a week. Similar results have been realized in Galicia, and in good drilling ground over 100 ft. a day have occasionally been sunk. But rapidity of drilling by this method can only be realized in wells of moderate depth, because the time occupied in screwing and unscrewing the rods is considerable, and in deeper wells the advantage as to speed belongs to the rope system. In order to exemplify this, the author is able to give the following record of the time occupied in drawing and letting down the rods at a deep well in Galicia, Austria, as noted by himself. The well at the time was 470 m. deep, *i. e.*, 1,542 ft., and sunk by competent drillers:

	Minutes.
Drawing up the rods	25
Letting down the sand pump by means of rods	14
Drawing it up	24
Changing the chisel	3
Letting down the chisel	14
Connecting the beam	5
Total	85

The author observed the same operation performed, with the rope, for a depth of 1,600 ft., in the Bradford oil district in Pennsylvania, when the time occupied was found to be about twenty minutes. A small wire rope worked by separate gear is sometimes used for lowering, working and raising the sand pumps, in which case the eighty-five minutes mentioned above would be reduced to fifty-five minutes. But this arrangement cannot always be applied. For instance, in Galicia, Austria, where the Canadian system of drilling has been successfully introduced, it is the custom to line the bore holes or wells with riveted sheet iron casing, instead of lap-welded tubes, for reasons of economy, and these are put in telescope fashion, leaving the inner length of casing slightly projecting. It is evident that it would be absolutely impossible to keep the sand pump perfectly steady in its rapid descent, and consequently the danger would arise of striking the projecting rims of the casing, and thus damaging, and perhaps destroying, the well. The experience of the author justifies him in condemning this mode of lining oil wells. The first cost is certainly much less, but the economy is more apparent than real. In bad ground the sheet iron riveted pipes are apt to bulge in, and owing to the loose riveting and the open space at the junction of each string of casing, the lining of the bore hole cannot be perfect. Moreover, if the well yields oil for several years, the thin wrought iron is certain to corrode, and fresh casing will have to be put in. Lastly, the sheet iron casing will not bear moving, and cannot be drawn out of the well when it comes to be abandoned. In a trial boring intended only to explore the strata, the short life of the casing is not an important factor, and in this respect sheet iron may be used.

The so-called Canadian drilling rig as used in Austria, and in the boring to be described, consists of a derrick or staging 56 ft. high, 16½ ft. square at the base, and 3¼ ft. square at the top. This is usually constructed of timber; but of late years derricks of wrought iron have been introduced, which have the advantage of being easily taken to pieces, removed and put up again. In the front of the derrick is a narrow door, about 15 ft. high, to enable the tools and casing to be taken into the structure. The engine is fixed in a shed adjoining the derrick. The boiler in another shed, placed at some distance, when the boring is for oil or in strata likely to emit explosive gases. The derrick is close-boarded. It is supported on "runners" or sleepers which are fixed on balks of timber termed "mudsills." The engine is of a simple horizontal construction, having one cylinder 10½ in. diameter and a flywheel. On the flywheel shaft there is a pulley which drives, by means of a strap, the "band wheel," which is about five times the diameter of the pulley. This "band wheel" works one end of a walking beam up and down by means of a connecting rod attached to it by a pin, revolving in a circle about one and a half times the diameter of the pulley. On the other end of the walking beam is fixed a spring pole sustaining the drilling tools, by means of a short piece of chain, gripped in spiral cast iron grooves firmly fixed on the end of the spring pole; this chain is wound round a reel fixed on the walking beam about the position of its fulcrum.

The apparatus is designed, by the oscillations of the walking beam, to give an up-and-down movement to the rods and string of tools in the bore hole. In the rig used the fall allowed was 18¾ in. The reel above named enables the chain to be paid out as the boring descends, by means of a "slipper out," which is a combination of pawl and ratchet acted on by a string at the command of the driller. Besides the drilling apparatus proper, there is another appliance attached to the engine for removing or replacing the various tools in the boring. When it is to be worked, the walking beam connecting rod must be disconnected, then the driller, by the aid of a brake, can control the appliance, which consists of a winch capable of winding up on its barrel a length of rope equal to the length of one of the rods. The rope is carried over a pulley at the top of the derrick and terminates with a heavy cast iron weight called a "cow sucker," to bring the rope down to the level of the bore hole. On the lower end of this there is an attachment screw fixed on a swivel, which fits others on the rods and tools. The swivel enables the driller to turn the tools round, an operation which is necessary in all kinds of drilling where a simple bit or chisel is used, in order to keep the hole round and the bottom level.

It is not necessary here to catalogue all the tools used in the Canadian system of drilling, as most of them are common to all methods of boring; suffice it to state that a "string of tools" consists of the jars, sinker bar, guide and chisel. It is frequently necessary to undercut in the process of boring, for which purpose an instrument called a "rimer" is resorted to. The rimer used in the boring at Freistadt was fixed about 2 ft. above a chisel of smaller diameter, and consisted of two projections or wings of steel slung on pivots, which were pressed outward by means of a spiral spring, so that while being lowered down in the casing the wings rubbed against the sides, but immediately they reached the body of the casing they sprang out and cut away the ledge left by the chisel. All the tools are fitted with conical screw joints, and it is important that these joints should have exactly the same thread so as to be interchangeable. As the poles are drawn up they are received and detached by a workman at the top platform of the derrick, while the driller at the ground level rests them on the wrench block, a piece of timber covered with sheet iron, and having a rail at one end to prevent the poles from sliding off. The combination of parts in the Canadian apparatus is designed to give the driller complete control, within limits, over the velocity with which the chisel strikes the bottom; the highest velocity of the chisel being that of the end of the walking beam when its movement brings it to a horizontal position. The driller regulates the velocity of the tools in accordance with the nature of the ground to be bored through. It is needless to state that he has the engine under his control by means of a string communicating with the throttle valve. The velocity of the chisel in the free-fall system is that due to the height from which it is allowed to fall, which does not exceed about 4 ft.

The rig thus succinctly described was the one used in the boring undertaken for the purpose of an exploration for coal in Austria, the details of which form the subject of this paper. However, before deciding on the adoption of the Canadian method for this purpose, the advisability of using the diamond drill was considered, and a shaft was sunk to a depth of 30 ft. to ascertain the exact nature of the strata near the surface. The only advantage of using the diamond drill would have been to secure a core of the carboniferous rocks, and identify them with the known beds found in the pits of neighboring collieries. Otherwise the diamond drill is not reliable for proving coal properties. A core can only be secured in passing through hard ground, and in the carboniferous measures, the clays, soft shales and coal seams, unless of a very hard nature, may be passed through without obtaining a core or record. In this case, however, the overlying tertiary beds were of such a nature and thickness that the diamond drill would have been quite inapplicable. The bore hole was put down in an unexplored part of the Austrian Silesian coal field, known as the Ostrau-Karwin coal basin, which is situated close to the north-west frontier, and forms an extension of the Prussian Silesian coal field. It is the only important deposit of palæozoic coal in the Austrian dominions; lignite and other coal exist in great quantities in Bohemia, Carinthia, Hungary, and other provinces, but palæozoic coal only in the Ostrau-Karwin coal field and over a very small area in Bohemia. The importance of this coal field to Austria can scarcely be overrated, as it is the only source of supply of coke and iron furnace coal in the country. The basin, so far as known at present, extends from Schonbrunn in the west to Karwin in the east, a distance of about 24 kilometers (15 miles) and the average width is about one mile, so that the basin as known covers an area of 15 square miles. The seams proved up to the present time number 26, with an aggregate thickness of 43 m., more or less. These seams are not all workable, but 13 are over one meter thick and one of the lower beds attains a thickness of 8 m. 16 c., with a small clay parting of 46 c. The end of the coal formation to the north and west is well defined by an outcrop of culm beds. Toward the south the boundary is also defined by limestone of the secondary period. But in the easterly direction at Karwin, where the seams are being worked without any signs or indications of a break beyond ordinary faults, the end of the coal basin is not defined. The greatest part of the basin is covered by beds of clay belonging to the tertiary formation, varying in thickness from a few yards to 250 yards. This deposit of tertiary clay is considered by Austrian geologists to be similar to the beds of the Vienna basin, and is locally known by the name of "Tegel." It is divided into two beds, of which the lower one is so tough that it has to be blown down with gunpowder in sinking shafts, but in presence of water and air it soon disintegrates and swells, so much so that sinking through it is a difficult and expensive operation. It contains small quantities of chloride and iodide of sodium. The two beds of this tertiary deposit are considered by Herr Stur to be identical with strata on the shores of the Mediterranean, and he classifies them as Neogene—a name given by some Continental geologist to the groups of Pliocene and Miocene strata. To the eastward of the existing pits this clay deposit continues, and until lately there was no positive evidence as to its thickness in this direction. However, some years ago a bore hole was sunk about a mile east of the extreme easterly coal workings to a depth of 269 yards into the clay without passing through it. This bore hole gave out a great quantity of coal gas, so much so that an explosion occurred in the drilling shed, which destroyed the machinery and stopped the bore hole; and it was assumed from that circumstance that the coal seams were not very distant. The great probability of the coal seams extending toward the east of the basin was also supported by the fact that the Prussian Silesian coal field lies in that direction, and the Ostrau-Karwin basin has always been accepted as forming part of this extensive field. These and other facts drew attention to the advisability of putting down a bore hole to test the extension of the coal. A concession of some 2,000 acres was secured by lease and this boring was undertaken for the purpose. In the western part of the basin the tertiary deposit has an average thickness of 50 to 100 yards. In some points the coal measures crop out to daylight, and at others they are covered by the tertiary deposit to a thickness of 250 yards. At Karwin, the extreme eastern point of the basin under exploitation, the thickness of tertiary clay is 90 m. Beyond this point toward the east nothing was done to discover the continuation of the coal measures except the bore hole already referred to, until it was decided to put down, under the direction of the author, the bore hole now to be described.

About two miles to the north of the workings of the Karwin coal pits the river Olsa flows from east to west, and it was supposed possible that, through erosion, a considerable part of the upper coal measures would be washed away in the valley of the river and replaced by tertiary deposits. The bore hole already alluded to was the only exploring work carried out, and this proved 246 m. of clay and the presence of inflammable gas. The bore hole under consideration was placed on rising ground about 2½ miles from the extreme easterly workings of the Karwin collieries and 1¼ miles from the old bore hole, and was assumed to be favorably placed at the edge of the valley of erosion and in the direction of the general strike of the coal seams. In view of the nature of the ground at Freidstadt it was considered advisable to commence the boring with a diameter of 18½ in., which was carried down to a depth of 26 m. 60 c., when the caving necessitated lining the bore hole, which was done with sheet iron casing made of plates 3 mm. to 4 mm. thickness (about ⅛ in.) The boring was then continued within this lining with a chisel 17½ broad, down to 96 m. 47 c., and again lined with sheet iron casing. This string of casing was armed with a steel shoe and driven down from the surface by the walking beam. Within this the next length was put down with a 16 in. chisel a depth of 141 m., and lined with casing 14 in. in the clear. This was also driven from the top, so that the upper three strings of casing were put down from the surface. The next length was bored with a chisel 13½ in. down to 40 m. 95 c., and lined with a 12 in. casing. This casing was not put down from the surface, but telescoped in the outer casing. It was also armed with a steel shoe, and it was attempted to force it down, as the upper casing had been from the surface, but this was not very successful, and the attempt to force the casing below this was abandoned. The boring was continued with a chisel 11¾ in. down to 82 m. 80 c., and lined with 11 in. casing, which telescoped with the upper casing for about 1 m. The next chisel was 10½ in. and the casing 9 in., length 28 m. 17 c.

Then followed	38 m.	lined with	8½	in casing.
" "	28 m. 13 c.	"	7½	"
" "	29 m. 15 c.	"	7	"

The bore hole had now reached a total depth of 388 yards, and as no signs of change of ground were perceptible, it became clear that it would have to be put down to a considerable depth. The last five strings of casing had averaged 102 ft. and had lost 5 in. in diameter over a depth of 170 yards, or at the rate of 1 in per string. The diameter of the bore hole was now 7 in., and taking 4 in. as the smallest working diameter, there remained 3 in. for casing, or 3 strings of 31 m., say 93 m. This was not considered enough depth, and the author then determined to continue the boring with lap-welded artesian casing with screw joints. Accordingly a string of 6 in. casing was put down, extending from the top, and the boring continued with a rimer or under-cutter giving a diameter of hole 6 in. This case was securely fastened at the top, and when sufficient ground had been undercut one and sometimes two pipes of 5 m. length were screwed on at the top and the whole length let down by means of a set of strong pulley blocks.

The boring was successfully carried on by this process to a depth of 435 m. 95 c., when an accident occurred which interrupted further progress. On the 2d of October, 1890, in moving the artesian casing in order to add a length at the top, the screw of the third pipe from the surface slipped and the whole string of casing dropped to the bottom. Every effort was made to raise it without success, and the author then determined to continue the boring from the depth of 436 m. 95 c., now cased with 6 in. casing, by running a string of 5 in. artesian casing inside the 6 in. casing. This was accordingly done, and the hole was successfully carried down to a depth of 613 m. 15 c. The 5 in. casing had been lowered to a depth of 581 m. 49 c., that is, 144 m. 14 c. below the 6 in. casing; at this point, in trying to lower the 5 in. casing, it was found that it was held fast by the swelling clay. Under the circumstances it would have been necessary in order to continue the boring to put in a third string of artesian casing 4 in diameter, and as this would have been the last string under any circumstances, sheet iron might have been used. The former would have secured a further depth of 150 m., the latter probably 80 m. to 100. In either case a new set of smaller tools would have been necessary, and under the circumstances, considering the great depth already reached without any decided change in the ground, it was determined to stop further drilling, as the discovery of the coal at such great depth would not have been of compensating value. As soon as it was determined to stop the drilling, arrangements were made to draw the casing out of the bore hole. On the 11th of April, 1891, this work was commenced. The casing had now been standing in the bore hole for five weeks, and it was to be expected, would be tightly jammed by the clay. Therefore, every precaution had to be taken. It was soon found that the fall blocks were insufficient to move the casing, and a pair of jacks had to be applied. By this means the first pipe of the 5 in. artesian casing was raised inch by inch out of the bore hole. The next 87 pipes were raised by the pulley blocks, and the remainder hanging quite free in the 6 in. casing, were raised by the rope and drum of the rig. The 6 in. casing, which had run down, was caught again by letting down a length of three pipes and screwing them on from the surface. But on attempting to raise them the screw slipped again, and only the three upper pipes were raised. An attempt was then made to raise the casing by letting down an expanding tool made of steel, and intended to secure the casing by cutting

into it. But the casing was so jammed by the swelling clay that the instrument on being drawn up ripped through the wrought iron casing and came up damaged itself, but without moving the casing.

The boring was commenced on September 29, 1889, and stopped on March 20, 1891, at a depth of 613 m. 15 c., equal to 2,011 ft., having occupied one year five months and five days. During this period several delays occurred, such as waiting for tools and casing, a few accidents intervened, and in the early part of 1890 the fire box of the boiler gave way, and had to be repaired, which caused a delay of six weeks. Taking the time occupied in completing the boring, namely 520 days, the averaging sinking amounts to 3 ft. 10 1/5 in. per day. Eliminating the stoppages, and taking the time of effective working, namely 265 days and 12 hours, the drilling amounts to 7 ft. 9 in. per day. These 265½ working days were employed as follows:

Drilling	190 days	8¾ hours.	
Using the sand pump	42 "	2¾ "	
Putting in casing	9 "	1 "	
Fishing up broken tools	8 "	3¼ "	
Small repairs to engine and rig	15 "	20¼ "	
	265 days 12	hours.	

The actual drilling averages 10 ft. 6 in. for twenty-four hours. The greatest distances drilled in one day were: 22 ft. 4 in. at a depth at 174 ft., 20 ft. 4 in. at 300 ft., and 22 ft. at 1,883 ft., and 21 ft. at a depth of 1,922 ft. The bore hole was perfectly straight, and ended at the total depth of 2,011 ft., with an internal diameter of 4⅕ in. The point of interest attached to this boring is the great thickness of clay which has been passed through. The mere depth is not very considerable as compared with many other bore holes put down in recent years, but the author is not aware of any bore hole which has been put down through over 2,000 ft. of swelling and adhesive clay. At times the chisel stuck so fast in the bottom that it took all the power of the engine to drag it out, and frequently the rods broke. On two occasions the chain gave way, and some conception of the strain may be formed from the fact that it was made of 1 in. iron. When the chisel stuck, and the full power of the engine was applied, the whole rig oscillated about like a ship at sea, yet no serious accident occurred during the process of boring, and it is a great point in favor of the Canadian system that this, which may be considered a difficult boring, was successfully carried out by that method. It may be interesting to state that inflammable gas was first observed at a depth of 702 ft., and from that depth onward became more abundant as the boring proceeded. When drilling was not going on, the noise of the bubbling gas in the bore hole was like the boiling of a gigantic caldron. A strong fresh water spring was struck at 960 ft., and a little down at 1,010 ft., a spring strongly charged with salts, mostly chloride of sodium, but also some bromide and iodide. The quantity of these valuable salts contained in the brine from the "Tegel," is about 1·50 grammes per 10,000 grammes of water. A similar spring of iodide and bromide salts was found in the boring previously referred to, and after the explosion, which stopped the sinking, this spring was profitably applied. In the winter the brine is pumped up and evaporated to dryness, and in summer it is used for baths and drinking in a bathing establishment erected for the purpose in the vicinity. The cost of this bore hole can only be approximately given. It amounted to over £2 per foot. The work was not carried out by contract, and the cost includes the purchase of the tools, casing, and machinery, less the amount realized by their sale at the end of the work.

In conclusion, the author would observe that, taking one consideration with another, the Canadian system of drilling has many advantages. In ground where the strata are much inclined it is preferable to the rope system, because it is difficult to keep the hole perpendicular by the latter method. By the use of the jars a much greater rapidity of drilling is secured than with the free-fall tool. Lastly, in soft ground it is possible to bore and obtain a section, which could not be done with the diamond crown. The latter is admirably adapted for drilling through hard ground when a core can be secured, but in softer measures it is not reliable as indicating the nature of the strata, and it is well known that even a seam of coal may be passed through with the diamond drill and not be recorded in any way. The Canadian method of boring has hitherto been almost exclusively applied to petroleum wells in easy ground, but it can be used for deep bore holes through difficult ground, as may be seen from this boring successfully carried down upward of 2,000 ft. through nothing but clay.

The president said he was sure they would all be desirous of giving a hearty vote of thanks to Mr. Boyd for his valuable and interesting paper, and as he was not aware that they had ever before had a paper on that subject, it would be a useful addition to their *Transactions*. There were several questions he would like to ask; first, as to the height of the fall, as 2 ft. 6 in. seemed such a small fall, and he would also like to know the weight of the tools that did the duty of the blow at the fall; second, as to whether there was any mechanical apparatus for turning the tools round, or whether it was done by simple muscular exertion; third, with reference to the sheet iron tubes, ⅛ in. thick, whether the rivets would not foul the tools as they dropped down, on account of the thinness of the material; fourth, was any record kept of the temperature? He presumed the cause of the rods frequently breaking was the constant concussion.

Mr. Boyd, replying to the questions which had been raised, said that the total weight of the tools which he had had to deal with, which were the Canadian principally, ranged from 10 cwt. as a minimum to a ton as a maximum. It was an easy matter to turn the tools round, because when they came to the top there was just a moment at the turn of the engine when, irrespective of the weight, the whole set of rods and tools could be turned by means of a swivel, and when the machine was going at sixty or seventy strokes a minute a very small turn was sufficient to answer the purpose. As to the question of rivets and the linings, he referred to the statement in the paper that his experience justified him in condemning that mode of lining the wells, except it were of a very temporary character, such as exploring for coal, but in the case of water or oil wells of a permanent character experience had proved that it was preferable to use a substantial rather than the cheap sheet tubing which he had described. The difference in price between the two tubings would be as between 4s. and 12s. When they used the American connecting wooden rods they broke very frequently, not with the concussion, but with the draw-up, because of the adhesive character of the clay and the difficulty of getting the chisel out of it. As a general rule, when they were not putting down such a preposterous hole, as he called that with which the paper dealt, not through clay but through fair ground, the rods were broken when the chisel struck the bottom. He had taken the temperature on several occasions but did not consider the results worthy of record, because they came across a very large spring of fresh water at a shallow depth, which absolutely interfered with reliable results. He was glad to hear Mr. Stockley's defense of the American system. He, however, considered that they would be able to feel the blow at the bottom just as well through the ash poles of the Canadian as the hemp rope of the American, for there could not be much difference in the rigidity of the ash pole and of the hemp rope. He admitted, however, that the American system had two advantages, viz., that they could bore a hole of much smaller diameter and they could bore much more rapidly than was the case with the Canadian system. He added that his experience in drilling in Pennsylvania was that he always found difficulty in keeping a straight hole with the American system, in spite of all the measures that were adopted. His experience in deep coals in Hungary and Galicia, where the strata were of an entirely different order, owing to the existence of the Carpathian range, was quite different, for they had to drill at angles at from 1 in 45 to 1 in 80; there the American rope system had been tried and found wanting, but the Canadians had come over, and by rearranging the tools they had been able to bore down there to depths of 1,500 or 1,600 ft. In order to keep the hole straight the only way was to use guides, whether working with the Canadian or the American system. The length of the pole used in the boring was 42 ft. As to the cost of sinking wells by the Canadian system, he had sunk them for 16s. a foot, while other wells cost as much as 30s., but the average cost might be taken at £1, the difference entirely depending upon the character of the ground they had to pass through. He had been somewhat taken to task on the question as to the depth at which they might find coal of compensating value. That was a point on which he could speak with some accuracy. In that case they sank down over 2,000 ft.; there was no change of ground whatever from a depth of 1,000 ft., and they could see not the slightest trace of the coal measures. Supposing, within the next 100 yards, they had struck the sandstone above the coal measures, it was a question of how much deeper they would have to sink to strike the coal itself. It would be at least 1,000 yards before they got to the first seam, and it was thought, considering the great outlay in sinking to that seam, it was not worth getting at that depth. Replying to other questions, Mr. Boyd said that the largest tubes were about a yard in diameter, but there was practically no limit to the size; the stuff inside the tube was carried out by means of a sand pump; that ordinary cartridges were quite sufficient to remove anything that the chisel would not move; and that while 20 lb. was sufficient pressure of steam when drilling, they required a pressure of 60 lb. to bring the tools up. The deepest hole that they had been able to discover was 5,000 ft., but he did not see why they should not make their arrangements for 10,000, 20,000 or 30,000 ft.

GAS MOTORS FOR STREET RAILWAYS.

MR. WM. E. MCKAY, U. S. Consul General for Germany, reports to the State Department as follows:

There is in the mechanical record of the past year in Germany no fact more noteworthy than the trend of expert opinion in favor of gas engines as motors for street and suburban railway cars. This has come at a period when electricity seemed to be on the point of replacing and superseding all other forms of motive power for this special purpose, and when the construction, equipment, and economical working of street railways have been more than ever before in this country the subject of practical experiment and scientific study.

In a general way Germany has hitherto been far behind the United States and some other countries in the adoption and extension of street railways. The rapid increase of population in the cities and industrial towns has recently attracted special attention to this subject, and, before investing their money and giving up their streets to tramways, the various municipalities have, with characteristic foresight, taken up the study of the several competing systems in a very thorough and deliberate manner.

The objections to horse railroads are well known. Although cheap and easy of construction, and although horse cars are the simplest and lightest vehicles that have ever been devised for such a purpose, such roads are unclean, and, in the end, expensive to operate. Horses and forage are both costly in Germany; the animals are exposed to accident and disease, and in case of war would be subject to immediate conscription for military purposes.

Steam tramways are noisy, terrifying to horses and timid people, dirty by reason of smoke and soot from the engines, and, what is still more serious, they can only be operated profitably on lines where the travel is regular, constant, and sufficiently heavy to require one or more cars to be attached to the motor vehicle. Recent improvements have modified to some extent the first two of these difficulties. There are in operation, for instance, on the suburban line between Wiesbaden and Bieberich, locomotive cars which run quietly and emit little or no soot or smoke; but they cost nearly $6,000 each, require both an engineer and fireman, and are for other reasons impracticable for street service in crowded cities.

Cable roads are costly to build. Their construction involves the tearing up of streets and underground constructions, which the German municipalities are loath to permit, and in operation the cable must be kept going throughout its entire length, with all incidental loss of power through friction, the same during all hours of day or night, no matter what may be the varying requirements of travel. Then, unless a double line is provided, the breakage or jamming of the cable or any accident to the engine paralyzes instantly the entire system. So that, while cable roads are admitted to be most advantageous for steep ascents, they are considered in this country as open to grave objections for ordinary use in crowded streets.

Electricity, as now applied, solves many of the difficulties which have hitherto beset other methods of propulsion, but every one knows that the noise, the danger, and unsightliness of overhead wires, and the high cost, as well as the waste and uncertainty of underground lines, are serious objections, and entail general complaint. Here, too, the current must be worked at full energy whether there are 10 cars or 20 or 50 in service at any specified moment. Of course, all scientists hope and expect that a perfect storage battery system will yet be developed, which will abolish both ground and overhead currents, and make each car independent; but at Brussels and Hamburg, where storage battery cars have been extensively utilized, the accumulators must be changed once in from 3 to 5 hours, and weigh from 2 to 4 tons for each car, giving a dead weight and cost of manipulation which, added to the large percentage of loss in electrical energy, leave this method at its present stage open to serious objections from a practical standpoint. Twenty, or even ten years hence, the storage battery motor may be the ideal one, but it is not so yet.

The problem from the German standpoint has been to devise a motor which shall render each passenger car independent—one which, during days or hours of increased travel, can draw one or more additional cars, which can be run upon rails laid at any reasonable grade without overhead wires or any subterranean construction; a car which can be started and stopped quickly and surely by one man, which can be supplied in any required number during the busy hours of the day, and when not in use can be run into a shed and left, without consuming or wasting anything, ready for immediate service when needed; a car that shall run silently without hissing steam or defiling smoke, and which shall be withal not too costly in construction or too complicated to be handled and kept in order by an average mechanic.

These requirements, in the opinion of many experts, narrow the choice down to two forms of motive power—coal gas and compressed air. The use of compressed air for such purposes is perhaps still in its infancy, but its advantages are frankly conceded. It is clean and quiet, it causes no smell or unpleasant heat, and the car is under perfect control, and is wholly independent of wires or other connections along the line. But in Berne, where air compressed by water power under highly advantageous conditions has been used, it is found that at a pressure of 32 atmospheres 4·2 cubic meters of air are required to produce one horse power, or about 150 cubic feet per horse power per hour. Each car carries 12 reservoirs, with an aggregate capacity of 2,170 cubic feet, which can be filled from the main reservoir in 8 minutes. Thus provided, the car, which at Berne weighs when empty about 7 tons, can run 12 miles, but at an expense of 15 cents per car mile, which exceeds the cost of horse power. On certain lines which lead through luxurious suburbs, where travel is heavy and high fares may be charged, compressed air may be recognized as the ideal motive power of the future. But since it is found that in Berne, with all its advantages of compression by water power, the cost of operation exceeds that of horse cars, the chances would seem to be against its general adoption for ordinary city and suburban lines.

A careful study of the whole subject has led to the adoption in two notable instances of cars propelled by gas engines. These practical trials have been made at Neufchatel, in Switzerland, and at Dresden, and the results in both cases, although not yet perhaps wholly conclusive, have been so favorable that they seem to be worthy of examination. The conditions to be met in Neufchatel and at Dresden were somewhat different, but they are substantially similar to those which exist in many of the smaller cities of the United States.

At Neufchatel there was required a new line 3⅕ miles in length to connect that city with the village of St. Blaise. Nine-tenths of the distance lies outside of the city limits, and through a district which could furnish but few passengers. The estimates had to be made on a basis of one car either way every half hour during 14 hours daily service, with an average of seven passengers per car, each paying 5·7 cents for the through outward or return trip. The contract for the equipment was let to a firm in Vevay, which undertook and fulfilled the task of providing motor cars to be driven by gas engines supplied with ordinary illuminating gas from the city mains. These cars are strong and practical in construction; they run quietly, without jar or smoke, stop and start quickly, and the machinery requires to be cleaned but once a week. Each motor car carries 20 inside passengers, and weighs, when filled, about 6 tons. They cost, delivered at Neufchatel, $2,856 each. These cars can pass curves of 100 ft. radius, run backward or forward with equal facility, and with 7·9 horse power are able to traverse any part of the line—which is 40 ft. higher at the midway point than at either terminus—at a speed of 11 miles per hour. Gas compressed to 6 atmospheres is furnished by the city gas company at $1.09 per 1,000 cubic ft., and it is found that under such conditions the cost of gas per car for the round trip, 6½ miles, is 19·3 cents, or about 1 cent per passenger for a filled car, or half a cent per passenger for the single run from Neufchatel to St. Blaise or return. This brings the net operating expense per passenger so far below the cost of electricity, horse power, steam, or compressed air that, although the experiment is still new, the problem is thought to be solved in favor of gas for all roads of a similar class.

But by far the most elaborate and interesting experiment is that which has been made at Dresden, where a street railway about three miles in length is operated with gas motor cars invented by a German engineer named Luhrig, and built by a company at that place, the engines themselves being supplied by the well known Gas Motor Fabrik at Deutz. This system has been in operation for several months, and has been the subject of careful study and investigation by committees and experts from other municipalities which have

in contemplation enterprises of a similar nature. Among others, the city of Nordhausen sent a commission headed by a government railway engineer to examine and report on the working of the new system, and the report of this committee, while recognizing that there remain some minor difficulties yet to be overcome, declares the system a practical success and recommends its adoption at Nordhausen. At Dessau another line to be similarly built and equipped is now under construction, and will be put in operation during the present summer. Germany has therefore definitely started toward the adoption of gas motor cars for a certain class of roads, and the experiment has reached a stage at which it deserves the attention of practical engineers in other countries.

The Luhrig motor car is built to accommodate 16 passengers seated within, with standing room for 5, besides the motor man on the front platform and 6 on the rear platform. Passengers are not allowed in Germany to stand in the aisles of street cars holding to straps. Under the American system of crowding and packing, one of the Luhrig cars would carry perhaps 40 people. Power is supplied by two double cylinder gas engines of 7 horse power each, located on either side beneath the seat and carefully inclosed in zinc sheathing, which excludes gas and smells and protects the machinery from dust and contact. Under the framework of the car are located at each end four cylindrical reservoirs, the whole eight having an aggregate capacity of about 360 cubic ft. of gas—sufficient to run the car 11 miles over a road in which the grades do not exceed 1 foot in 20. The cars weighs, without passengers, 7½ tons, and can be made for from $3,500 to $4,000, according to the number included in one contract. The cylinders of the engine are kept cool by water circulating through pipes leading from a cylindrical reservoir carried on the roof of the car, the heated water rising and the cold descending automatically, and with such satisfactory results that after a run of several miles the warmth of the cylinders may easily be borne by the naked hand.

Gas is supplied from the ordinary street mains, and is compressed to 8 atmospheres by a simple double barreled force pump worked by a stationary gas engine or other power, and at this pressure the reservoirs of a car may be filled through a flexible pipe in less than a minute. Gas costs in Dresden $1.05 per 1,000 ft., and, in view of the advantage which such a wholesale, all the year round consumption would offer to gas companies, it is safely assumed that most of them will be quite willing to erect compressing machinery at their own cost and deliver the gas to the motors at the prescribed density. The car is managed by one motor man standing on the front platform, who, with throttle and governor, regulates the speed at will from 150 to 240 engine revolutions per minute.

As the double engine gives a motive force of 14 horse power, a second car may be attached whenever needed, thus doubling the capacity of the line during hours or days of greatest activity. A loaded car climbs a grade of 1 in 15 at a speed of 4 miles per hour, but for satisfactory work in all weathers and seasons the grades should not exceed 1 in 20.

In an address delivered before the German Gas and Water Supply Association some weeks ago, Chief Engineer Kemper, of Dessau, submitted a comparative estimate for the construction and equipment with gas motor, electrical, and horse cars of a street railway 5 miles in length and requiring an outfit of 20 cars for ordinary service. In these estimates double tracks for all, two compressing stations at $2,500 each, sheds, etc., for the gas motor cars, are included; for the electrical roads, dynamos and overhead wires, and for the horse cars 120 to 150 animals, with the requisite stabling and fixtures, the intention being to show the comparative cost of building and putting into operation the same road under each of the three systems. The exhibit is as follows:

Electrical	$180,880
Gas motor	142,800
Horse cars	133,280

The original construction and equipment account is, therefore, slightly in favor of horse cars as compared with gas motors, though both are notably cheaper than the electric plant. But this difference in favor of horse power rapidly disappears when the cost of daily operation is taken into account. As the result of careful study, Mr. Kemper states the net operating expense of horse cars in Germany at 5½ to 7 cents per car kilometer, against 5 cents for electric cars and 4 cents for gas motor cars of the Luhrig model per car kilometer. There is thus claimed an economy in motive power of 25 per cent. in favor of gas as compared with electricity, and from 60 to 75 per cent. in comparison with horse power. It may be safely assumed that every town with area and population sufficient to require street car service has already a gas supply, and gas companies will everywhere be willing to favor this new and important outlet for their product by offering long contracts at favorable rates. Otherwise two or more street car companies could profitably combine and manufacture their own gas supply.

It is, of course, too soon to declare that the entire problem has been definitely solved, and no one will pretend that the Luhrig motors (which have undergone several improvements since being put into service) have reached or even approached the ultimate standard of utility; but the superior economy of gas motors over other means of propulsion for certain classes of tramways seems to be conclusively proved, and from this secure vantage ground whatever difficulties yet remain will surely be mastered.

HIS EXCELLENCY SEÑOR DON LUIS CORDERO, PRESIDENT OF THE REPUBLIC OF ECUADOR.

DR. DON LUIS CORDERO, with whose portrait we adorn the columns of our paper, was born in what is now called the Province of Cañar, in the Republic of Ecuador, on April 6, 1833.

In November, 1847, after having received primary instruction from his father and overcome many obstacles caused by his limited resources, he entered the Seminary of Cuenca, an excellent institution in which have been educated most of the notable men of the Department of Azuay.

He had scarcely concluded his academic studies when he was made secretary of this college, in which he served also at different times as professor of grammar, natural philosophy, mathematics and the humanities.

At the beginning of 1862 he obtained the degree of doctor of jurisprudence in the Universidad Central de Quito, dedicating himself to the exercise of his profession until the year 1867, when he entered business.

In this year he went to the national legislature as deputy for the Province of Azuay. It might be said that this was the beginning of the political career of Señor Cordero—of liberal modern principles, energetic in his opinions, indefatigable defender of public liberty, devoted to all progress, he attended several congresses of which he was a most notable member on account of his upright ideas and his great eloquence.

When the republican institutions were trampled down by the dictatorship of General Ventimilla, in the year 1881, Señor Cordero was one of the first to raise his voice against such scandalous usurpation; and when the patriotic forces that had risen in different parts of the republic for the defense of the constitution and laws took the city of Quito by force, the people of this capital—united in a popular committee—chose a pentavirato to take charge of affairs until the convocation of a national convention and the election of new public functionaries could take place. Señor Cordero was a member of this pentavirato.

In the year 1892, and after the sad death of General Don Francisco Jovier Salazar, Señor Cordero was nominated as a candidate for the presidency of the republic in the following constitutional period by the republican party, to which all of the most prominent men of Ecuador belong.

Elected president after a hard struggle, he followed in the footsteps of his predecessors and succeeded in preserving the peace of the republic. He has given especial attention to public instruction, but without neglecting the other branches of his administration.

Finally, when the question of boundaries arose between the governments of Ecuador and Peru, the Republic of Ecuador beheld the beautiful spectacle of all her sons united for the national defense; and this, which shows so clearly the patriotism of the Ecuadorians, also speaks well for the prudence and tact of Señor Cordero, who was then president.

Although we have written this slight sketch of the career of Señor Cordero, it is impossible to have a complete idea of him if we consider only his political life.

The study of science and literature have always by preference occupied much of Señor Cordero's time, and his numerous poetical compositions and prose writings manifest the fruitfulness of the mind of him who is rightly known as one of the best poets of South America.

Señor Cordero is devoted to the study of the natural sciences, and has published several valuable pamphlets on the subject of the flora of Ecuador.

He is well versed in the Quichua language (the language of the aborigines of Chile and Peru), and has lately written a dictionary of this language which received a special premium in the Columbian Exposition at Madrid, in 1892.

The poetical compositions of Señor Cordero began to appear in the different literary periodicals of the republic after he studied the humanities.

The "Antologia de Poetas Ecuadorianos," published in 1892 by the Academy of Ecuador (which corresponds to the Royal Academy of Spain), of which Señor Cordero is a member, adorned its pages with his most notable composition, entitled "Aplausos y Quejas al inspirado Cantor de la Raza Latina, Don Olegario V. Andrade."

The distinguished Argentine poet, Don Olegario V. Andrade, in his "Atlántida: Canto al porvenir de la Raza Latina" (Atlantida: Song to the Future of the Latin Race), had forgotten Portugal, the republics of Central America and Ecuador. Señor Cordero, in the composition to which we refer, wished to repair the injury done to his country.

Many critics of high standing have compared the two compositions referred to, conceding the higher place to that of Señor Cordero.

The high tone, the sublimity of the expressions, and enthusiasm of this composition cause it to be considered one of the best products of South American talent.

HIS EXCELLENCY SENOR DON LUIS CORDERO, PRESIDENT OF THE REPUBLIC OF ECUADOR.

TELEPHONE RATES IN EUROPE.

THE following particulars about the rates for telephones in various countries may be of interest:

In Austria-Hungary the rates are uniform for all the state telephone exchanges. The state telephones cover the whole of the country, except the city of Vienna. The total charge is made up of an installation charge, which for a distance of not above 500 meters amounts to £5 (50 gulden), and for every additional 100 meters £1; then there is annually a station charge of £3, and what is called a working charge of £2, so that the annual charge is about £5.

In Switzerland the charge has been by degrees reduced to about £3 3s. (80 fr.) As a result of this low tariff the number of telephones has rapidly increased, and at the end of 1891 there were about 12,595 telephones.

In France the telephones are a state affair; the annual charge for towns with over 25,000 inhabitants is £8 (200 fr.) and for smaller towns £6 (150 fr.)

In Italy the telephones, in accordance with the telephone act of 1892, may be worked either by the state or by private enterprise. For the smaller and medium-sized towns the annual subscription ranges from £5 to £6.

Sweden boasts of an exceedingly well-managed and greatly developed telephonic system, which comprises both an extensive and ever-growing state telephone system and numerous private concerns. The rates are on the whole very reasonable; as a rule, a subscription of £4 10s. will cover an area of about a mile from the exchange. For smaller towns the rates are somewhat lower (£1 to £1 10s.) Private companies have as low annual subscriptions as £1 13s.

In Norway the subscriptions vary according to the size of the towns, but are on the whole moderate; they range, as a rule, from £2 4s. to £4 9s. It is at present under discussion to erect a very extensive system of state telephones in Norway.

In Spain most of the telephone companies are private concerns; the annual subscriptions vary considerably, say from £3 to £11.

In Holland, the Netherlands Bell Telephone Company has almost monopolized the telephones, and the subscriptions are fixed according to the size of the towns. In Amsterdam, for instance, the subscription is about £10 (118 gulden); in Rotterdam, £10; in

Grovenhagen, about £8 10s. (110 gulden); in Haarlem, Utrecht, Arnheim, Groningen and Zaandam, which are towns with something like 30,000 inhabitants, only £5 (60 gulden). In still smaller towns the annual subscriptions are reduced to £4 or £3 10s., and even these low charges are subject to further reductions by contracts extending over several years, etc.

The telephones of Belgium are partly state and partly private affairs. There are no uniform subscriptions, but the charges are registered according to the distance from the central station and the term of subscription. The charges for the state telephones are, for a distance from the exchange of one kilometer, £6. The usual charges for private companies vary from £5 to £6.

In Luxemburg the charges vary between £3 and £4.

In Denmark the Copenhagen Telephone Company, which through a state telephone cable has connection with Sweden, charges about £8 6s. 6d. (150 kr.) annual subscription. The subscriptions in the provincial towns vary considerably, from about £1 12s. 6d. to £4 4s.

In Germany the telephones are almost exclusively state institutions, and the charges are on the whole high.

In England, finally, the National Telephone Company charges from £20 annually in the city of London down to £10 or £8 in smaller towns.

RIGHT AND LEFT SIGHTEDNESS.

IT is of course a well known fact that certain members of the body are inclined to be, as we say in speaking of the hands, right and left handed, but it is not generally known that the organs of vision are affected in this manner. That is to say, people who, while apparently looking with both eyes, use only the right eye or the left eye.

Manufacturers of fire arms, when making guns to order, carefully allow for the right or left sightedness of the sportsman. The gunmaker takes a card and pierces it with a hole one-half a centimeter in diameter; this card is given to the sportsman, who holds it thirty centimeters distant from the eyes and looks through the hole at a fixed point, Fig. 1. The hole and the point are always in a direct line with one of the eyes, with the right eye if the person is right sighted, with the left eye if the person is left sighted. To replace the hole and point to their original position, after being used by a person who is right sighted, the card must be moved to the left.

Figs. 2 and 3 show another form of the experiment which every one can perform. The experimenter who is right sighted tries to hide from both eyes with the index finger (without, however, succeeding, on account of the convergence of the visual axes) the face of a watch. Next he closes the right eye. At once his finger appears out of the line from his left eye to the watch face some twenty degrees.

It would be interesting to measure exactly the amount of the variations and reduce them to tabular form. The Marquis of Camaras, who has brought this subject to the attention of the readers of *La Nature*, says that out of twenty persons examined, two were left sighted, one being a woman. It would be particularly interesting to know if marksmen are left sighted. Women are more often left sighted than men, and when they are right sighted, they are so in a lesser degree than men. For the particulars given above and for the illustrations we are indebted to *Le Monde Illustré*.

NICKEL—ITS HISTORY, USES, AND DISTRIBUTION.*

By A. G. CHARLETON, A.R.S.M.

HISTORY AND USES.

THE subject of this paper is one which the author begs leave to present, thinking that it may be profitably considered. His own interest was awakened in nickel some years ago when making an inspection of an important group of nickel mines, and the works connected with them, in Germany, but the superior attractions of gold and silver mining have prevented him till now from reviving it. The discovery that nickel was a new element was made by Cronstadt in 1754, and he named it after the mineral kupfer-nickel, in which it was discovered by him, but it was reserved to Bergman in 1779 to show that nickel was really a new metal. Kupfer-nickel was described by Hierne in 1694, and its name indicates the low value set upon such ore by the German miners in those days. Kupfer-nickel, in fact, might be freely translated into English as "Old Nick's copper," the term nickel being probably derived from the Low German "nikker," which stands for the devil or hangman.

Deceived by the copper color of the mineral, the miners, no doubt, mistook it for copper ore, and probably gave it the name to warn future generations against what they, not unnaturally, regarded as a fiendish imposition on them; the miners, however, would, no doubt, tell you that it was due to the metallurgist's command of bad language, as they discovered that when cobalt ores became over-roasted in the manufacture of smalt the nickel they contained followed the former metal, and, combining with the silica, spoiled the blue color of the glass the makers wanted to produce. To quote a most instructive paper on nickel, read before the Colorado Scientific Society, December 4, 1893, by W. T. Austin, one may say that "Nickel has not received from scientific men the attention to which it is entitled, and the subtile influences exerted on the physical properties of its alloys by the admixture of exceedingly small quantities of other elements have mystified the practical man (so called by courtesy) and kept him in the background. For more than a century nickel puzzled and perplexed all who had anything to do with it, and its history is a long story of contradictory statements and mistakes." It seems to me it is a capital metallurgical illustration of the proverb, "Give a dog a bad name." But, granted so, a bad dog may sometimes be broken in, and become of service to its owners.

FIG. 1.—Instrument for Testing Right and Left Sightedness.

The literature dealing with the subject is exceedingly scanty, on the one hand because the properties of the metal have been insufficiently studied by those who would naturally be expected to investigate them from an economic point of view, and, on the other, because the interests of pure scientists in this field have for some reason lain dormant. Another cause is the secrecy maintained for so long a time by those manufacturing nickel products with regard to their processes and methods. This policy, which, it is to be presumed, has generally for its object the idea of deterring competitors from entering a special field, is surely a short-sighted one, as it may well be doubted whether manufacturers are ever benefited in such cases by jealously excluding the scientific discussion of their methods of treatment; experience in the rapid development of the iron and steel trades, in one instance, at any rate, going to prove the benefit of adopting an opposite policy.

Nickel has certainly maintained a high price in the past, but at the cost of an exceedingly limited consumption of the metal, and the original discoveries of ore in Scandinavia, Germany, and the United States furnished the trade for many years. It was only with the increased demand for the metal, induced by its more extended applications, that prospectors began to busy themselves and look around for larger supplies of ore, and the result has been the discovery of most important new fields, like those of New Caledonia and Sudbury, in Canada.

Austin traces four marked stages of development in the modern history of nickel.

1st. The century or more when the presence of some unusual metallic combination was recognized to exist in certain minerals, during which time the metal was introduced into the arts as an alloy known as "white copper," consisting chiefly of copper and nickel with a small proportion of zinc, closely resembling silver, tough, easily worked, and not tarnishable when exposed to gases containing sulphureted hydrogen.

2d. The period which commenced with the manufacture of German silver on a large scale at Berlin (about the year 1824), when nickel obtained a recognized position, Brandes having shown, the year previous, the exact composition of the new alloy.

Up to 1838, nickel was wholly derived from its arsenide ores, and it was not till then, when Berzelius is thought to have discovered nickel in the Kiefva ores (Sweden), that Aschen made his first smelting experiments upon the nickeliferous pyrrhotites and pyrites of that country. The metallurgical losses were at first heavy, but between 1849 and 1851 Berdberg laid down certain principles, which have held good in nickel metallurgy up to the present time.

3d. The period which dates about this time (1850, when Switzerland adopted nickel for subsidiary coins) marks another era in the history of the metal. In 1888, it was first successfully alloyed with steel on a scale of commercial importance, and this has given nickel a fourth periodic impulse, which has only just practically commenced, and promises to far exceed all the preceding ones in its results. The world's production of metallic nickel has increased within the past ten years from 1,000 tons per annum to over 5,000 tons, while previous to 1876 not more than 600 tons were produced in any one year. As far as our knowledge at present extends, the principal value of nickel seems to lie in the properties of its alloys. For example:

(1.) German silver is of such general utility that articles made of it are everywhere to be found in household use.

(2.) Alloys of nickel and copper have largely supplanted the smaller silver coinage of several European countries and America.

(3.) A small percentage of nickel incorporated into steel has provided the engineer with a structural material superior, for many purposes, to the best carbon steel made.

(4.) Pure nickel, in the metallic form, is used for plating other metals, and though its cost is at present too high to admit of wide use, it is employed for making numerous small articles.

To give one instance only. A short time back the interest aroused in me by nickel, combined with the conviction that silver, under existing international currency conditions, at even 29⅛ an ounce, was an extravagant luxury, induced me to extend the application of nickel, by having a cap of it set on the handle of my old but valued umbrella.

Austen predicts that nickel will be put into the form of ferro-nickel, suitable for making commercial steel, at no distant time, in not more than three operations, without innumerable by-products being left over to work afterward. At present, the simplest and most direct method of treatment includes at least seven distinct stages—roasting, matting, Bessemerizing—after which it has to be "topped and bottomed," refined, reduced to oxide, and finally incorporated, not to mention all the side operations of working up the by-products. It is a subject, indeed, to which English metallurgists might, in all probability, profitably turn special thought.

Before the Christian era, nickel was employed for coinage purposes by the Bactrian king Euthydemos, 235 years B. C., and analysis of these coins shows that they were evidently intended to contain 22 to 23 per cent. of nickel to 77 or 78 per cent. of copper, closely approximating, curiously enough, the proportion of 25 to 75 per cent., which, experience has taught us, is the most desirable admixture of these metals for use in coinage. It is remarkable that Euthydemos hit upon this particular ratio of copper to nickel, and the fact that analysis shows no arsenic debars rich arsenical ores from being a source from whence the nickel employed was derived, and points to the use of sulphides, as the silicates could scarcely have been treated at that time. If this be so, it indicates considerable metallurgical skill on the part of the early smelters, and, considering the nature of the metals employed, it is hardly probable the alloy was a haphazard mixture.

Prof. Roberts-Austen mentions also that long before Europe awoke to the value of nickel, that enterprising person, "the Heathen Chinee," was making an alloy of nickel, and shipping it to Europe for a century or more, under the name of "Pack Fong,"* or "white copper."

Just before the commencement of the second period, before alluded to, nickel appears to have been discovered in the United States, when, in 1818, Seth Hunt opened the cobalt mines near Chatham, Conn., and shipped some of the ore to England, where it was reported upon and stated to contain nickel. These mines, in 1854, were said by Whitney to be the principal sources of American nickel, but from the fact that

* A paper recently read before the Society of Arts.—*From the Journal.*

* According to an analysis of a specimen in Dr. Percy's collection at South Kensington, composed as follows: Copper, 4·4 per cent.; zinc, 25·4 per cent.; nickel, 31·6 per cent.; iron, 2·67 per cent.

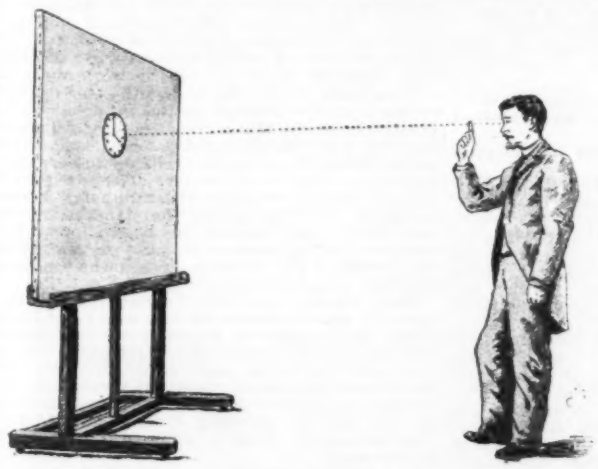


FIG. 2.—Disappearance of a Dial Behind the First Finger for a Right-sighted Person, the Left Eye being Closed and the Right Eye Open.

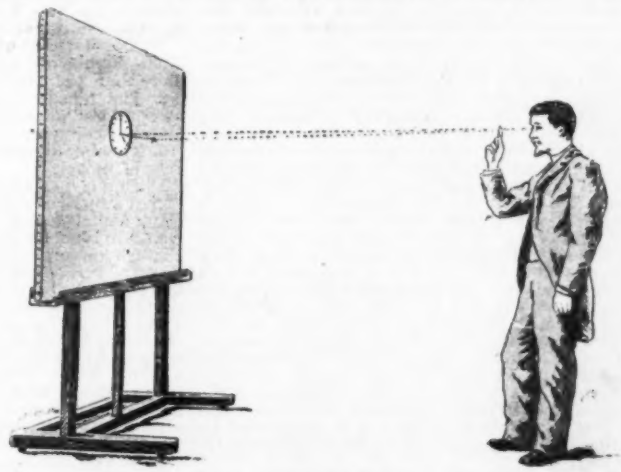


FIG. 3.—Apparent Deviation of the First Finger and the Reappearance of the Dial for a Right-sighted Person, the Left Eye being Open and the Right Eye Closed.

they were repeatedly taken up and abandoned, they no doubt proved commercially unremunerative.

The principal deposit of nickel opened to date in the United States, the celebrated Gap Mine, appears to have been discovered somewhat later, viz., in 1718, and was being worked for copper in 1744. It was not, however, till 1852, when the property came under new management, having proved unsuccessful as a copper "proposition," that investigations began to be made as to the nature of the yellow sulphide ore, looked upon as worthless mundic by the former owners, and thrown by them over the dump. The first tests were not conclusive; but, in 1853, Dr. Genth, of Philadelphia, pronounced it to be millerite. During the third period in the history of the metal, in 1862, Joseph Wharton acquired the Gap property, and put it into operation as a nickel producer, in May, 1863, starting a refinery at Camden.

At the Centennial Exposition in Philadelphia, in 1876, Wharton made an exhibit of nickel products such as had not been seen elsewhere up to that date; and in 1878 he showed articles made of pure nickel, both forged and cast, which were so remarkable that they excited at first considerable incredulity.

In 1804, Richter had succeeded in producing malleable nickel, but subsequent investigations met with very variable results, through neglect in recognizing the important part played by small quantities of impurities alloyed with the metal. A new future for nickel as a metal, apart from its alloys, dawned when, in 1879, Fleitmann found that by the introduction of small amounts of magnesium just before pouring, the quality of the nickel was improved, Garnier subsequently accomplishing the same end by the use of phosphor-nickel. This third period is likewise marked by the important event of the discovery, in 1876, of immense quantities of hydrated silicates of nickel and magnesium (garnierite) in New Caledonia, which placed an exceedingly valuable material at the disposal of manufacturers, opening up the possibility of producing a purer nickel from ores free from the usually accompanying deleterious substances, reducing the price of the metal, and extending its uses. Nickel ores had been discovered in the island some years previously, but it was not until 1876 that they began to influence the market. These new ores contained the nickel in the form of protoxide, free from cobalt, copper, sulphur, and arsenic, and, consequently, required an entirely different system of treatment from that by which the sulphide and sulpho-arsenide ores had been handled.

Some years previous to the appearance of the New Caledonia silicates at the metallurgical works of Europe, somewhat similar ores had been worked at Ickatarinenburg, in Russia, others were known to exist in Spain, and since then further deposits have been found in Oregon and North Carolina.

In 1876 the production of the Scandinavian mines reached its maximum height, the yield of Norway being 360 metric tons of metal, and that of Sweden considerably less than 100 tons. Since that date the production of this district has very considerably declined.

Nickel silicates were discovered in Douglas County, Oregon, in 1881, and have lately been exploited by an Anglo-American company, while in 1884 deposits of nickel ores were proved to exist in Churchill County, Nevada.

The Pacific Coast mines are said to be the most promising deposits at present known to exist within the boundaries of the United States, but distance from market, and the discovery of nickel in Canada, have militated against their development.

In 1856 Mr. Alex. Murray pointed out the occurrence of a dingy green magnetic "trap" at a point ten miles southwest of what is known as Sudbury, in Canada, and this rock, upon analysis, showed small quantities of nickel and copper.

The first discoveries of any commercial importance were not made until the building of the Canadian Pacific Railway, in 1883, and early in 1884, when a cutting on the line pierced a small hill about three and one-half miles southwest of Sudbury, exposing the deposit since known as the Murray mine.

In the spring of 1886, the Canadian Copper Company was formed to operate the Copper Cliff (Stobie and Evans' mines), but it was not till 1888 that the company erected their first furnace. Shortly afterward a number of companies entered the field, among others Vivian & Co., of Swansea. These Canadian mines, which are in the districts of Algoma and Nipissing, in the province of Ontario, have of late years attracted world-wide attention, first, on account of their apparently inexhaustible character; lately, because of the new applications of nickel in the manufacture of nickel-steel. One is apt to overlook nickel in its mineralized forms, and the Sudbury ore bodies were originally opened as copper mines.

The unusual properties displayed by meteoric iron, in regard to its extraordinary toughness, and in some instances its non-corrodibility, coupled with the fact that it is invariably associated with nickel and other elements, has of late years drawn attention to the influence which nickel exerts when alloyed. Faraday, Berthier, Longmaid, Liebig, Fairbairn, and Boussingault, Kunzel, and even Ledebur, all investigated the subject, but all efforts to manufacture a valuable alloy of iron and nickel were in vain until a few years ago, when the fourth era of nickel commenced; the trouble was that the immense influence of minute quantities of other accompanying metals and metalloids was unsuspected. Probably, the first appearance of nickel-iron alloys in the United States was when Philip Thurber, of Detroit, exhibited some products of the iron furnace at Marquette, Michigan, at the New York Exposition in 1853. This iron was made from a nickeliferous limonite, and possessed some remarkable qualities, but it was not till 1888, after experiments had been made by Marbeau in France, with crucible nickel-steel alloys, that James Riley took the subject up, and began experimenting in Scotland with similar manufactures, produced in the open hearth, and convinced himself and the metallurgical profession of the genuineness of the claims advanced for this new material. The results are given fully in a paper read by him at the Glasgow meeting of the Iron and Steel Institute, May, 1889.

Notable among these was an alloy containing 4·7 per cent. nickel, which showed an elastic limit of 28 tons per square inch and a breaking strain of 40 tons, whereas similar steel without nickel showed only 16 tons and 30 tons, respectively. The elongation and contraction of area of this steel were not moreover materially impaired. In a series of competitive armor trials, made at Annapolis, Maryland, in September, 1890, the palm was awarded to a French nickel-steel plate, and Mr. Tracy, at that time Secretary of the United States Navy, gave orders to have further trials of similar material made, which had been manufactured of American material by American mills, with a view to decide the best material for protective armor for the new men-of-war being built. These tests, as reported by Mr. W. S. Abbott, of Carnegie, Phipps & Co., gave an ultimate tensile strength of 100,000 to 102,000 pounds per square inch, with an elastic limit of 59,000 to 60,000 pounds. The elongation was 15½ per cent., with a reduction of area of 29½ and 26½ per cent. respectively at fracture.

The toughness of nickel-steel is shown by the fact that blocks cut from the armor plates at Bethlehem, many of them weighing several tons, cannot, by any method yet devised, be profitably broken up into sizes suitable for returning them to the furnaces. It is stated also that experiments lately made by the German government show that shells exploded in ordnance made of ordinary steel badly injured it; while with nickel-steel, it was only enlarged. New York *Engineering and Mining Journal*, March 11, 1893: "Ordinary gun steel contains 0·3 to 0·5 of carbon, and may contain 0·8 of manganese."

One by one objections raised against nickel-steel have been removed, the effect of cold weather on the plates, for instance, having been experimentally demonstrated to be of no consequence, if one may judge from a series of experiments carried out at the United States navy yards since 1891.

The tough, tenacious material flows under the impact of the shot, and in the case of "Harveyized," *i. e.*, surface-hardened plates, the extreme hardness of the exterior, reinforced by the tough untreated steel behind, shatters the forged steel Holtzer projectiles, which have hitherto proved irresistible.

These shells are made, I believe, of highly carbonized steel, containing 0·8 to 0·94 of carbon, and, in addition, 0·94 to 2 per cent. chromium. Nickel-steel is practically incorrodible, and can be advantageously made on the basic, open hearth furnace. Professor Roberts-Austen, p. 48 of his valuable "Introductions to the Study of Metallurgy," states that nickel has an atomic weight of 58·60, atomic volume of 6·7, specific gravity of 8·80, specific heat, 0·110, melting point, 1,600, coefficient of linear expansion, 0·0000727, electric conductivity, 7·374. Quoting the investigations of Riley, he gives a diagram, which shows that nickel up to 7 per cent. materially increases the tensile strength of steel and its elastic limit, while its extensibility is as rapidly diminished.

Though there has been no material increase in the established channels of consumption, except it be for plating, while 1,000 tons of nickel flooded the market in the early years of the century, 10,307,275 pounds, or, roughly, five times as much, was produced in 1891, consequently the large excess of metal produced must have gone into nickel-steel, yet this alloy has scarcely begun to be used in the arts of peace. As its price tends steadily downward, we may confidently expect that it will eventually enter into competition with other materials for other purposes than armor plates and guns. Though there is always naturally some hesitation in adopting a comparatively untried material, where it is subjected to extremes of temperature, such as for boiler plates, bridge building and marine engineering, experiments are going on all around us, and last year it was decided to place sections of nickel-steel propeller shafting in the United States protected cruiser Brooklyn* and the battleship Iowa. The ordinary carbon-steel used for such purposes has a tensile strength varying from 60,000 to 65,000 pounds per square inch, whereas the nickel-steel will show a tensile strength of 90,000 pounds per square inch, the elongation in both cases being about the same, 20 per cent.

Using this stronger steel will warrant boring out the shaft, materially lessening the weight while preserving its efficiency, and such cored shafting can be hollow forged when the hole is large enough to admit a mandril.

If it is found possible to apply it to the construction of boilers, the tensile strength of nickel-steel being 1½ times that of ordinary steel, it will enable their thickness to be reduced one-third, effecting a saving in weight, which is often a great consideration. Jules Garnier gives in *Le Genie Civil* the results of a series of tests made in 1892, at the Cleveland Rolling Mill Company's works, on nickel-steel. The nickel was produced at the Brooklyn Nickel Works, from Sudbury ore, by the Canadian Company. The comparative results of these trials, by the side of others on ordinary steel made and tested under identical conditions, are given in the New York *Mining Journal* of February 25, 1893, and the deductions drawn from them were:

1. Nickel-steel has a higher elastic limit of some 11,400 pounds per square inch, or nearly 31 per cent. more than ordinary steel.

2. The tensile strength of nickel-steel is greater by some 10,400 pounds per square inch, or an increase of about 20 per cent.

3. The ductility of steel is not reduced by the presence of nickel.

During last summer the Bethlehem Iron Works completed a spare crank shaft for the American liner Paris, using nickel-steel of about 90,000 pounds T. S., which is said to be 25,000 pounds in excess of any German or English manufactured steel, with the exception of the material turned out by one firm in this country, which has adopted steel of a similar character. Another important channel of consumption is the manufacture of a nickel-copper alloy (Ni 20 per cent., Cu 80 per cent.), for casing bullets to be used with small bore rifles now adopted by all the armies of Europe. This alloy has a higher degree of tenacity than the best brass, combined with a higher coefficient of elongation. The possibilities opened up by the uses to which nickel alloys may be applied by engineers in different branches of business may well attract the attention of miners and capitalists to deposits from which supplies of the metal can be got. The ores of nickel include the following minerals:

* New York *Engineering and Mining Journal*, November 26, 1892.

Sulphides.

	Nickel per cent.
Millerite, NiS	64·6
Polydymite, Ni_4S_5	59·4
Beyrichite, Ni_3S_4	54·2
Pentlandite (FeNi)S	34·0

Arsenides and Sulpho-arsenides.

Niccolite, NiAs	43·9
Rammelsbergite and cloanthite, $NiAs_2$	28·1
Gersdorffite, NiAsS	35·4

Sulpho-antimonides.

Breithauptite, NiSb	32·8
Ullmanite, NiSbS	27·8
Wolfachite, Ni(AsSb)S	29·8
Coryite, Ni(AsSb)S	28·8

Silicates.

Genthite, $2NiO.2MgO.3SiO_2.6H_2O$	22·6
Garnierite, $H_2(NiMg)SiO_4 + Ag$	25·0
Connarite, $H_2Ni_2Si_2O_{10}$	31·4
Rewdanskite $(NiFeMg)_2Si_2O_7 + 2H_2O$	28·1

Sulpho-bismuthide.

Kallilite, NiBiS	19·0

Telluride.

Melonite, $NiFe_2$	23·8

Oxides and Salts.

Bunsenete, NiO	78·5
Nickel oxide, Ni_2O_4	73·1
Morenosite, $NiSo_4 + 7H_2O$	20·9
Annabergite, $Ni_3As_2O_8 + 8H_2O$	29·4
Cabrerite $(NiMg)_3As_2O_8 + 8H_2O$	25·1
Forbesite, $H_2(NiCo)_3As_2O_8 + 8H_2O$	14·4
Lindackerite, $3NiO.6CuO.8o_3.2As_2O_5.7H_2O$	12·9

Carbonate.

Zaratite, $NiCO_3.2Ni(OH)_2 + 4H_2O$	46·8

It may be mentioned that millerite has been found in Iowa, forming tufts of beautifully arranged needles, in large, perfectly transparent crystals of calcite, in the compact lower carboniferous limestone of the Keokuk quarries, some 20 feet below the "geode-bed," in cavities running up 20 inches in length, thickly set with rhombohedrons of this peculiar character.

(To be continued.)

[Continued from SUPPLEMENT, No. 962, p. 15375.]

THE ADULTERATION OF FOOD.*

By H. W. WILEY, Chemist of the United States Department of Agriculture.

IT is hardly patent to this lecture to refer to foreign countries, but it may be said that in general the best laws in this country, national and federal, are based on the English food and drugs act, which is entitled an act to make better provision for the sale of food and drugs in a pure state. This became a law on the 11th of August, 1875.

The laws of the continental countries of Europe are also in the main effective, but contain such a multitude of minutiæ as would render them very burdensome if enacted in this country. The English law has been in operation long enough to prove its efficiency, and under it hundreds of convictions for the sale of impure foods and drugs have been secured.

The Canadian law is essentially the same as that of England, although not so comprehensive.

The States not heretofore mentioned have, so far as could be ascertained, no laws relating to the adulteration of foods. At least they were not reported, although inquiries were sent to the Secretary of State of each State in the Union for information in regard to this matter.

Many municipalities also have local laws applying to the sale of adulterated foods. These laws are mostly of a specific nature and apply chiefly to dairy products. There would be no time here to even mention the cities having local laws on this subject, but there are now very few large cities in the country which do not at least have some kind of milk inspection.

Lying at the root of the question of food adulteration is the inquiry, What is meant by pure food? In the laws which have been enumerated, attempts have been made to legally decide what pure food is. Divested of all legal technicality, pure food is a wholesome article of food or drink which is sold and consumed under its proper name. With each particular article there must be established a separate standard which a consensus of experience with a great number of known pure substances in that list shows to be required. For instance, take the case of milk, which is one of the most common articles of food, and perhaps has been more generally adulterated than any other one. Analyses made all over the world on hundreds of thousands of samples of healthy cow's milk have shown that the average content of solids therein is practically nearly 13 per cent. A normal milk which falls below this standard shows some peculiarity in the animal giving it, either an incipient disease, deficient nutrition or some idiosyncrasy. The mixed milk of a herd of healthy animals will rarely fall below this standard. For this reason the standard of 12¼ per cent. of total solids in milk has been adopted in most countries having laws on the subject. In some cases the benefit of the doubt is given to the vendor and a standard is fixed at 12 per cent.

Now, of these total solids a certain quantity in normal milk must be butter fat. It is not often that the butter fat of a perfectly healthy cow's milk falls below 3 per cent. of the total weight of the milk. It is much more apt to be 3½ per cent.; hence, in fixing a standard of pure milk not only must the percentage of solids be given, namely, 12 or 12¼ per cent., as the case may be, but also the quantity of fat contained therein. This percentage varies in different laws from 2¾ to 3¼ per cent.

In a similar method the standard of purity of any other article of food must be determined by a careful

* A lecture delivered before the Franklin Institute. From the *Journal of the Institute*.

examination of pure samples from all quarters, and by then fixing a standard below which an article must be regarded as suspicious or adulterated.

As a distinction between a pure and an adulterated article, take the cases of butter and oleomargarine. Pure butter, for instance, must be clean, sweet, wholesome and made of the fat of cow's milk, and must contain only a certain proportion of water, curd and salt. Oleomargarine may be as sweet, clean and wholesome as the butter mentioned above, yet when sold as butter it is clearly not pure food, but a spurious article.

Again, when the housewife buys lard it is supposed that the article she obtains has been made from the fat of healthy, freshly slaughtered hogs, carefully selected and cleaned and rendered in clean kettles or tanks. Cotton-seed oil and beef tallow, in respect of cleanliness, nutritive properties and wholesomeness, may equal and even excel pure lard, but the admixture of these articles with hog's lard, or their sale as such, without the knowledge of consumers, is clearly a fraud and an adulteration.

From a practical point of view, food adulteration may be considered under two general aspects, namely:

(1) Adulteration harmless to health and practiced merely for cheapening the article or making it more attractive to the sight or taste.

(2) The addition to a food or drink of substances positively injurious to health.

Such substances are added chiefly as preservatives or for the purpose of coloring or decolorizing, or for the purpose of giving a particular flavor or taste. As a rule, they are added in minute quantities. In fact, the proportion of such substances is usually so small that a moderate or intermittent use of food so treated may not produce any great injury to the system. The continued use of such articles, however, must end in the impairment of the general health and sometimes in permanent injury.

In the latter class of adulterations must also be included those injurious substances naturally arising from the decay of wholesome foods, or from the development of noxious substances in canned foods, or from the formation of poisonous salts by the action of the canned foods on the solder and tin of cans. Such materials, while not intentionally added, are, nevertheless, adulterations within the true scope and meaning of the term as applied to foods. In other words, it is not necessary to prove intent in order to establish the fact of adulteration. Any food which is not what it purports to be, which contains any unwholesome or poisonous ingredient, or which has any artificial coloring or facing material, is, to all intents and purposes, adulterated.

There is one legal exception to the above classification, namely, the use of annatto in coloring butter. The national oleomargarine law, applied to the Territories, the District of Columbia and to interstate commerce, permits an artificially colored butter to be passed as genuine, and I believe most State laws referring to this subject contain the same provision. Indeed, in some States oleomargarine exposed for sale is required by law to be stained pink or some other color distinctive from yellow, and such a stain, while an actual adulteration, could not be classed as illegal.

There is still another form of fraud in food which may be defined as a negative adulteration. It consists in extracting from a food part of some valuable ingredient, and selling the residue as the genuine article. The sale of skimmed milk for whole milk and of spent tea leaves for genuine leaves are illustrations of this kind of fraud. Perhaps the best method of illustrating these various kinds of fraud and adulteration will be to call attention to some of the articles sophisticated in the ways described. No attempt, however, will be made to give a complete list of adulterated articles, for such a list would fill a volume. Attention, therefore, will be called only to the more important articles of food, and to those which are most commonly adulterated. In addition to this, examples will be given of some peculiar forms of adulteration which are little known to the public.

Milk.—Normal cow's milk should contain about three and one-half per cent. of butter fat, and should yield, on standing in a cool place for twenty-four hours, from ten to twenty per cent. by volume of cream. Until the establishment of milk inspection in cities, whole milk was something of a rarity. With careful inspection, such as obtains in Boston, the percentage of adulteration has been largely reduced.

An ingenious method of milk adulteration is sometimes practiced by the shrewd husbandman in such a way as to preserve his tender conscience from being seared. The cream in the cow's udder is naturally separated in part from the milk, unless the cow, just previous to milking, be subjected to violent exercise. The first milking, therefore, is less rich in butter fat, and it can be sent directly to the consumer. The last of the milking, called strippings, on the other hand, is nearly pure cream, and can be preserved for butter making. Butter fat being lighter than whole milk cannot be removed without increasing the density of the remainder above the normal. This density, however, can be reduced to the proper limit by the judicious addition of water. The testing of milk by the lactometer alone is, therefore, not a certain method of discriminating between a pure and an adulterated article.

Condensed milk is made by evaporating whole milk at a low temperature and in a high vacuum, in copper vessels, yet even at this low temperature some of the distinctive aroma of the milk is carried off by the escaping vapors. It, therefore, happens that even when evaporated milk is diluted to its original volume with water, it is never exactly itself again. Yet a pure condensed milk is not an adulterated article, for it is sold as condensed milk, and hence no fraud is practiced. When, on the contrary, as is often the case, sugar or salicylic acid is added, in order more securely to preserve the condensed product, then a perfect case of adulteration is established. The manufacturer, however, may relieve himself of all responsibility, in so far as the addition of sugar is concerned, by stating on the label the amount added. In cases of deleterious preservatives, however, there would be no excuse. Their use in all cases should be prohibited.

Butter.—In regard to butter, the character of adulteration is well known. The use of oleomargarine as a butter substitute has been practiced for many years. The oleomargarine law, which imposes a tax of two cents a pound on the manufactured product, has not helped to restrict its use, but has rather increased it by giving to the consumer a guarantee of purity. The amount of tax collected on manufactured oleomargarine for the fiscal year ending June 30, 1892, was $945,675, which shows that there were 47,283,750 pounds of oleomargarine manufactured in the United States in twelve months.

The number of retail dealers in oleomargarine increased during the year more than 25 per cent. over the preceding year. The amount of tax paid by retail dealers for the fiscal year ending June 30, 1891, was $146,293.70, and for the fiscal year ending June 30, 1892, $204,215.

The increase in the number of wholesale dealers was nearly 100 per cent. The amount of tax paid by wholesale dealers for the fiscal year ending June 30, 1891, was $53,191, and for the fiscal year ending June 30, 1892, $106,036.

There can be no reasonable objection to the use of oleomargarine; it is clean, wholesome and digestible. When it is to be kept for a long time before use, as on ship board or in distant mining camps, it is preferable to butter, because it has but little tendency to become rancid.

Lard.—For similar reasons there can be no possible objection to the use of cotton-seed oil as a substitute for lard or when mixed with lard, provided it be sold for what it is. Most of you are familiar with the great fight which was made against the use of the term "pure refined lard," which was the trade name of a mixture of lard stearine with cotton-seed oil. "Pure refined lard," it was claimed, was a term which had been used so long to designate the mixed product that it had become in reality a trade mark, and was, therefore, entitled to respect and protection. In the investigation which was held before the Congressional committees, it appeared that as to the trade the contention was quite justifiable. Goods sold under that name were understood to be mixed. When, however, the mixed product was offered to the consumer, it was purchased with the idea which the name naturally implied, that an extra fine quality of hog's lard was secured.

All attempts to pass a pure lard bill, modeled on the oleomargarine act, have heretofore failed in Congress, but several of the States have prohibited the sale of mixed lard, except when offered under the proper name. Manufacturers have, therefore, been gradually forced to abandon the term "refined lard" when applied to this commodity.

I am of the opinion that many persons would prefer a cooking fat largely of vegetable origin to a pure animal product. To me, it seems that some State legislatures have taken a reprehensible course in prohibiting the sale of vegetable oils as a substitute for lard for cooking. The grower of hogs undoubtedly has a right to contend against the sale of vegetable oils as hog fat, but when he pushes his claim still further, and demands that the markets be closed to products as pure and nutritious as his own, he passes beyond the bounds of public support. Every person in the United States who prefers cotton oil to lard should be allowed to purchase his supplies without let or hindrance. Every grower and maker of pure lard has the right to an equally open market from which every adulterated and mixed lard offered as pure should be rigidly excluded.

For a time, a few years ago, when a popular fad prevailed in favor of nitrogenous foods, the true value of fats to the digestive and nutritive economy was not well appreciated. At the present day this is all changed, and we know how to value a fat properly.

It is, therefore, a matter of no mean importance to protect the public in the use of olive oil instead of cotton oil, of cotton oil instead of lard, and lard instead of a mixture of beef and cotton oil stearine. It is true that cotton oil, when carefully refined, is almost as good a salad dressing as olive oil, but it is very much cheaper, and those who prefer to pay the high price should be secured against fraud. In respect of wholesomeness and digestibility, it would be hard to choose wisely between the two.

One of the great difficulties in securing the enactment of a national pure food bill has been the feeling in cotton-growing regions that such a bill would restrict the market for cotton oil. This is true, if the fraudulent market is meant. By that I mean the surreptitious sale of cotton oil as olive oil and as lard. But such a bill would not interfere in the least with the legitimate market for this product. Cotton oil, as a food, has such merit of its own as to warrant the belief that it does not require any smuggling to secure for it a wide and rapidly increasing use. The South as well as the North would be the gainer from honest markets for honest foods, and it is a shortsighted policy that leads to a crusade against such legislation as will secure the desired result. It would be a rather unfortunate thing for the whole country should an irrepressible conflict between the *sus* and the *gossypium* keep our interstate market forever open to mixed or doubtful fats.

(*To be continued.*)

HOTEL HYGIENE.

AT a recent meeting of the Société Normande d'Hygiène Pratique, M. Percepied read a paper on the transmission of infectious diseases in hotels, where the bedrooms are occupied in turn by invalids and healthy persons. (*New York Medical Journal.*) It is principally in reference to the watering places or the winter resorts that the attention of physicians and of the public has been aroused, he says, and in a number of resorts the suggestions mentioned in this paper have been adopted and have given rise to reforms, still in their infancy, but destined to extend rapidly. It is a great mistake, in his opinion, to limit hygienic precautions to health resorts only; all hotels, whatever they may be, should have the same rigorous care. The condition of health of the people received at these hotels is not known, and, granting that acute infectious diseases are relatively rare, it is certain that invalids with chronic diseases, such as tuberculosis, are frequent patrons, and the fact that the majority of the travelers remain only a short time cannot be brought forward as an argument. They have the right to remain as long as they please, and they also have the right to demand that all sanitary precautions shall have been taken in the rooms that they occupy. The subject under discussion applies only to travelers, although there is much to be said with regard to hotel kitchens and lavatories, and, above all, to the condition of health of the cooks and the other employes who live there. M. Percepied confined himself to saying that kitchens should be provided with draught flues, and be sufficiently well ventilated for the odors not to pervade the hotel. Infectious diseases are due to germs that are very unyielding and retain their virulence for a long time, and these germs may be in every part of a room that has been occupied by an invalid; in the bedding, as well as on the walls or on the floor. Knowledge of these facts imposes the necessity of modifications in order to render the rooms habitable and free from danger to those occupying them. First of all the room should afford air in proportion to the number of persons occupying it, and should be well ventilated and sunny, for the importance of sunlight and air as hygienic factors is well known. The walls should be hard finished or coated with an impermeable paint which can be washed, and, so far as possible, all corners should be rounded to make them accessible to washing. Mouldings, unless rounded, should be discarded. Carpets should be rigorously prohibited, and a parquet floor, which can be washed, substituted, or a covering of linoleum of an artistic and pleasing design used. An advantage to be gained by this is the abolishing of the spaces which always exist between the boards of an ordinary wooden floor. If the traveler desires to be more comfortable, he can have a movable carpet or rug, on condition that after his departure it is beaten and passed through a disinfecting bath before it is used again. The same precautions should be taken with regard to carpets. In rooms that are not very much used a heavy linen covering can be substituted for carpets, which can be sent to the wash like clothing. For the same reason curtains should not be tolerated, except those that can be washed. White ones are preferred, as the monotony can be relieved with a border of embroidery in bright colors. Heavy materials, like plush and velvet, should never be used. The furniture should be very simple in design, so that it can be cleaned easily. Wooden furniture, wardrobes, bureaus, and toilet tables should be varnished or waxed, or, if preferred, lacquered. Chairs should have caned bottoms. Thus it is possible to conform strictly to hygienic laws, and at the same time preserve an artistic appearance. Everywhere, where it is possible, brass or iron bedsteads should replace those of wood. Toilet articles, especially the glasses, should be washed every day with the greatest care. After the departure of a patron they should be washed in an antiseptic solution, such as a half per cent. solution of corrosive sublimate, and the bedding, towels, etc., boiled in alkalinized water. With regard to the means of lighting hotels, electricity is to be preferred, although that is a question of secondary importance. The heating should be with wood, coal, or coke. After a room has been occupied by an invalid, all the bedding and other linen should be sent to the disinfecting bath, and the walls, boards, and furniture submitted to antiseptic washing and antiseptic spraying. These precautions should not only apply to the bedrooms, but extend to the different rooms that the patrons have used, although with less strictness. The curtains of the parlors, where they remain but a short time, do not require such rigorous treatment. Nevertheless, draperies should be avoided and carpets prohibited. The same precautions should be observed in the dining room. Here particular care should be given to the washing of the glasses, the forks, and the spoons. The former, after each meal, should be washed in an antiseptic liquid, and afterward well rinsed in clean water, and the latter in boiling water. The vestibules, halls, and stairways should be without carpets and should be wiped every morning with a cloth wet with an antiseptic liquid. The closets should be large and well ventilated, and have proper appliances for flushing. These precautions should extend to the rooms of the employes, where the sanitary conditions should be under the strictest surveillance. As soon as a case of sickness is discovered isolation should be practiced, in order to take the necessary precautions as regards disinfection. These are the measures, the author says, which should be resorted to at the present time, and failure to do so shows a culpable indifference. At first it may seem that these precautions would be a source of expense to the hotel keepers, but the abolishing of curtains, carpets, and furniture covered with rich silks and velvets will prove economical for them in the end, and, if they are properly carried out, any danger of infection will nearly always be averted.

SOME THOUGHTS ON PHARMACY AS A PROFESSION.*

By SAML. P. SADTLER, Ph.D., Professor of Chemistry.

IT is estimated that there are at present some 40,000 druggists in the United States. Now, if we had an army of 40,000 trained and experienced veterans and the question was as to the addition of some 600 new recruits (supposing that to be the number of graduates this year from the different colleges of pharmacy), we would not entertain the idea for a moment that such an addition could exert any notable influence. But if we consider the responsibilities attaching to the work of a pharmacist, its close relations to the practice of medicine and the fact that the issues of life and death often depend upon the skill and accuracy of the compounder of medicines as well as upon the learning and judgment of the physician, and then reflect that of these 40,000 druggists not over 8,000 at most have had the education of a school of pharmacy, the case presents a different aspect. We must then look upon the strengthening of this educated element among the druggists by some 600 new recruits, freshly drilled in the most recent advances of science and the results of the best methods of manipulation, carefully gathered for them by able and experienced instructors, as a very important matter. It is the sending out of new leaven which shall work through the whole body of practicing pharmacists, strengthening what is good in it

* Abstract from the valedictory to the class of 1894, Philadelphia College of Pharmacy.

and exerting influences that may in time be powerful and far-reaching.

The recurrence of this annual event, the commencement of full professional activity for the large body of young men now before us, we believe this has some importance for the profession into which they are about to enter. At the same time it gives us an opportunity to pause for a few minutes and look at the condition of the profession of pharmacy, to consider some of the drawbacks to its prosperity existing at present, and to consider suggestions for its improvement.

The profession of pharmacy is a peculiar one. It differs in important respects from the so-called learned professions of law and medicine, not in requiring less, for a competent pharmacist must be well grounded in quite a range of the sciences, but in the peculiar conditions under which it is practiced. It is considered unprofessional for the lawyer or the doctor to advertise, but the pharmacist is a vender as well as a professional man, and is expected to bring his wares to the notice of the public.

And just here arises the first danger to him as one who has a profession, for the practice of which he has been educated. It is to lose sight of the fact that if he is a professional man he must be content to rise slowly as the young lawyer or doctor does, to enlarge his circle of patrons gradually, but gaining their respect at the same time and holding it. He is tempted to look at the purely mercantile side of his position and to stoop to claptrap methods of drawing attention to himself and his store. This is said to show American "push" and "snap," but certainly there ought to be some other outcome than that from the years spent in acquiring a professional education. He may get the name of a "hustler," as it is termed, but does it not appear on closer inspection that such a reputation is gained in most instances at the expense of professional standing?

The methods of rush and push, of turmoil and struggle, have, I fear, completely taken control of most of the mercantile communities in our American cities and large towns; but would it not be better for the educated pharmacist to aid in keeping such methods out of pharmacy and by avoiding catchy efforts to attract trade, dignify his profession and his own standing in the community?

Of course it will be said, and with some truth, that in large cities especially, the competition is so great that the newcomer is obliged to push himself forward in order to get a foothold; that if he does not, he will be left behind, will starve, it is often said. But a man of good sense can soon see a difference between proper commendable enterprise and the unprofessional and sensational efforts to push one's self into notice, of which I have just spoken.

Again, the invasion of the apothecary's field by the patent medicine man and the cultivation and solicitation of the physician directly by the manufacturing druggist are drawbacks which the pharmacist has to contend with. But is it not the mercantile rather than the professional side of his activity that suffers, and is it not true that, in proportion as he has developed the professional side, he suffers less from these difficulties?

In other words, if he has become known as a skillful and able pharmaceutical chemist himself, who has kept up with recent progress in chemistry and pharmacy, he will suffer notably less from such drawbacks than if he had staked all his success on attracting attention to his store by advertising novelties.

Another of the drawbacks to the proper recognition of pharmacy as a profession is the comparison so often drawn between it and the related profession of medicine, and drawn, I need hardly say, in most cases to the disadvantage of the former. It is not alone drawn by the doctor, who from the time he leaves the medical college calmly draws a line between himself and the laity, as he calls the rest of the world. This superiority of the medical profession is too often conceded as a matter of course by the pharmacist, who feels the necessity of gaining the good will of the medical profession living in his neighborhood as a question of business. Is it any wonder, then, that the public take him at his own estimate and grow accustomed to give a respect to the one profession that they deny to the other? This difference in valuation is only encouraged when the pharmacist proceeds to demonstrate his belief in it by taking up medical studies, even after years of practical business life, and adding the medical degree to that of graduate in pharmacy. I do not wish to be misunderstood here. Many young men enter upon the study of pharmacy and pursue it diligently with the full intention from the beginning of following it by studies in medicine. For such a plan I have nothing but commendation.

I have repeatedly heard medical men, who had pursued this plan, acknowledge the invaluable aid that the thorough grounding in a knowledge of drugs and medicines and their preparation acquired in a college of pharmacy gave them in the after practice of medicine.

But cannot the graduate in pharmacy, who has had no such plan of study, who has only started out to acquire a pharmaceutical education, feel that he has a worthy profession before him, if he will but strive to make himself worthy of it? He has had an insight during his college years into the methods of work in chemistry, both analytical and synthetical, in operative pharmacy, the field of which is becoming wider every day, in microscopical study of plant tissue and drug structure. Is there, then, nothing that promises results for him in all this—results that will bring him both pecuniary reward and reputation?

I am not saying that, if he devote himself somewhat to these things, he will thereby come to the reputation of a Liebig in chemistry, or a Procter in pharmacy, or a Maisch in his knowledge of materia medica. But he will raise the standard of his profession and will be honored individually in having contributed to this result. Nor will the result be empty glory.

If the pharmacist is known to his neighbors and to the medical profession with whom he comes in contact as a good chemical analyst, a thorough botanist and pharmacognocist, and, above all, a skilled compounder of all classes of official pharmaceutical preparations, he can rest assured that he will succeed, if he has, in addition, good common sense. Of course all of these educational qualifications referred to may be thrown away on a visionary, rash and unpractical person.

[FROM NATURE.]

THE ARCTIC EXPEDITIONS OF 1894.

IT is not easy to speak definitely regarding the various Arctic expeditions which will be in the field this year, for several of the most loudly advertised ventures have collapsed or been postponed, and it is possible that some quiet and determined explorers may set out without calling public attention to their plans. There is undoubtedly to be keen rivalry in the North Polar basin for several years to come, and even an incomplete forecast of the projected work may serve to direct notice to the regions whence good results in the way of Arctic discovery may be looked for. It is unnecessary to insist in the pages of *Nature*, however needful the caution may be to the general public, that no credit for Arctic exploration can be given until the intending explorer returns, bringing with him proofs of his achievements which will bear the keenest criticism of experts.

Two well equipped expeditions have been in the field since last summer, working by different methods, from different sides, but both led by men of experience and manned by tested Arctic travelers. Nansen's expedition in the Fram appeals most powerfully to the imagination for the boldness of its plan and the faith with which its leader bases his success and even his life on the truth of his theory of ocean currents in the far North. The general trend of these currents, as drawn by Dr. Nansen, is shown on the accompanying map, which is reduced from one published in the *Geographical Journal*, vol. ii. His strongest evidence for the existence of a drift across the center of the polar basin was, as is well known, the discovery on the ice off the south of Greenland of relics from the American exploring ship Jeannette, which sank off the New Siberian Islands; but this was fortified by much additional information. The Fram sailed from Christiania on June 24, 1893, passed through the Waigatz Strait on August 3, and the last news was that on August 6 some Samoyeds saw her passing along the Yalmal coast between the ice and the land. Nansen intended to call at the mouth of the Olenek River in September before turning finally northward, but he did not do so. If he had called, or even been sighted off the coast, the fact would have been reported to Baron Toll, who was in the neighborhood of the Olenek until November. It seems probable that, making an easy passage across the Kara Sea, Dr. Nansen found sufficiently open water to induce him to turn northward off Cape Chelyuskin, as he was urged to do by Captain Wiggins, and that the Fram has passed the winter fast in the ice somewhere within the 80th parallel, possibly drifting poleward. No news can now be looked for by way of Siberia, and it is very unlikely, though just possible, that one of the expeditions going north this year, by Franz-Josef Land or Spitzbergen, may meet the crew of the Fram, where all the meridians converge toward the pole.

NORTH POLAR MAP TO ILLUSTRATE PROJECTED POLAR EXPEDITIONS.

Mr. Peary, after raising the necessary funds in America by writing and lecturing, returned to the scene of his former triumphs at Independence Bay on the northeast coast of Greenland. He and his party landed at Bowdoin Bay, on Inglefield Gulf, in Smith Sound, on August 3, 1893, and established themselves there for the winter, being comfortably settled when the steamer left on August 20. Sledging parties were at once dispatched to *cache* provisions at convenient depots on the inland ice on the way to Independence Bay. Mr. Peary intended to commence his main journey about the middle of March this year, and to reach Independence Bay in the first week of May. Here the party will divide, three men being dispatched to sledge southeastward and survey the coast along the quite unknown stretch to Cape Bismarck, returning thence across the ice cap to Inglefield Gulf. The other party will push northward from Independence Bay, and endeavor to completely survey the land which was seen across the strait last year, at the same time trying to attain the farthest north. The position of Navy Cliff, on the south side of Independence Bay, was fixed as 81° 37', and since Lockwood's farthest north was 83° 24', it is practically certain that Peary, with his great experience of foot travel on the ice, will be able to make his way more than the 125 miles which would carry him nearer the pole than any previous traveler. This year he is not to depend entirely on dog sledges, but to experiment with Mexican donkeys, which are accustomed to carry heavy loads in the low temperature and thick snow of the high Cordilleras. Whatever the result may be in record breaking of northern latitudes, we may confidently expect a great deal of solid geographical and scientific work from this expedition. A steamer will call at Bowdoin Bay to bring back the party, or at least obtain news of them, in August or September.

The third expedition left Tromsoe on May 1, 1894, for Spitzbergen, with the object of repeating the attempt so gallantly made by Parry in 1827, when he reached 82° 45'. It is under the command of Mr. Walter Wellman, a journalist, of Washington, who has carefully thought out his plan of action, and has commenced to carry it into effect without delay. Although he has had no previous Arctic experience, he is a man of great energy and enthusiasm; his companions are as enthusiastic and resolute as himself, and it is by no means improbable that he may be able to give a good account of his time. He terms his enterprise "a dash for the pole," and is determined to be back in America before the end of October. However, as a precautionary measure he is to provision the old seal hunters' house on Danes Island in the northwest of Spitzbergen for a year, in case of enforced wintering. The object of starting so early in the season is to avoid the strong southerly drift of the ice, which so greatly hampered Parry's sledging parties. Thus, if Mr. Wellman's theory is correct, he will reach his farthest north before the drift becomes serious, and have the southward drifting ice floes to help him on his return. By the use of very light boats, constructed entirely of aluminum, and provided with runners to convert them into sledges, the weight to be pulled will be greatly reduced. It is to be feared that Mr. Wellman's plan of taking Belgian draught dogs for his sledges will lead to difficulties on account of the difference in climate and in the nature of the work from those to which they are accustomed. The behavior of the aluminum boats will be looked forward to with much interest.

Finally, the Jackson-Harmsworth expedition will take the field early in July, having for its purpose the exploration of the polar area lying north from Franz-Josef Land. Mr. Harmsworth, who is bearing the whole cost of the expedition, has purchased the Windward, of Peterhead, a well known steam whaler of 320 tons, to take the party out to Franz-Josef Land, but the exploration will be conducted by land or across the ice. Mr. F. G Jackson, the originator and leader of the expedition, has long thought over this matter,

and devoted most of his time for two years to the study of Arctic problems. He spent a great part of last winter in the north of Russia, testing sledges and other appliances for ice travel and practicing surveying on the little known Waigatz Island. Like Peary, he intends to try the endurance of stronger animals than dogs in Arctic work, proposing to take a number of Russian ponies. The *personnel* of the expedition, although probably not exceeding six, will include trained specialists and collectors, who will map their route, make meteorological and magnetic observations, and collect geological, botanical, and zoological specimens. After calling at Archangel, in the end of July, to take on board a Russian log house, and then at Khabarova to ship West Siberian dogs and drivers, the Windward will proceed to Franz Josef Land and make a landing somewhere in the south of that region, the exact spot depending on the state of the ice. The route to Franz-Joseph Land will thus be due north from near Kolgueff Island, instead of northeastward from Norway, as shown on the map. The wooden house will be erected on a secure and sheltered site, and stocked with the necessary stores for four years, after which the ship will return. If, as seems possible from Payer's observations, Austria Sound should be found open, provisions will be carried north along it in a steam launch and *cached* for subsequent use. Mr. Jackson and his companions will spend the winter at their base, where the conditions of life were found to be quite endurable by Mr. Leigh Smith when he was compelled to spend a winter there, with very poor accommodation and equipment, after the wreck of his yacht, the Eira, in 1881. Early in the spring of 1895 the expedition would push northward, moving very slowly because of the necessity of traversing the distance several times over in order to carry the quantity of stores necessary to establish a depot every thirty or forty miles along the route. This slow progress will, of course, give an opportunity for repeating observations for position, and so add to the accuracy of the map. The direction of advance will probably be along Austria Sound and across Petermann Land, the farthest north sighted by Payer in the Austro-Hungarian expedition, and lying in 83° N. Should Petermann Land extend to the north, Mr. Jackson intends to proceed along it, mapping his route as he goes. Boats would be carried for crossing open water, and if oceanic ice intervenes, it would be traversed as rapidly as possible, and a return made to the farthest north point on solid land, where winter quarters could be established; but should this be impracticable, the retreat would be continued to the base, where the second winter would be spent. In the spring of 1896 the party would turn northward again, the chain of depots accelerating their progress. In the summer of 1896 the ship will return with additional stores and men, and to obtain news; but it does not appear to be Mr. Jackson's intention to return, unless he is satisfied that his work is final, until 1897. This expedition ought certainly to extend our knowledge of the most northerly land known, and if fortune favors it, the advances made may be great. Its equipment is of the very best, and no excuse of bad material can be brought forward to explain unsatisfactory results.

The expedition for the exploration of Ellesmere Land to which reference has several times been made in *Nature*, planned by Mr. Robert Stein, of the United States Geological Survey, has been postponed; we hope only until next season. Still, efforts will be made this summer to clear up the fate of the unfortunate young Swedish naturalists, Bjorling and Kalstenius, with their mate Gilbert Dunn, and cook, Herbert MacDonald, of whom the last news received was that they intended to seek shelter with the reported Eskimo of Ellesmere Land. Mr. Elis Nilson has been sent out by the Swedish Anthropological and Geographical Societies, on the Dundee whaler Eclipse, to visit the Carey Islands and Clarence Head, if the ice permits, and search for any relics of the missing party, whose fate, after two years without supplies, can scarcely be considered doubtful. Baron Nordenskjold has interested himself particularly in the search, and will probably arrange for other whalers to deviate from their course in order to obtain information.

Dr. F. A. Cook, the ethnologist on Peary's former expedition, has issued a prospectus of a pleasure trip which he is to conduct up Baffin's Bay to Smith Sound, with the opportunity of a slight change of route should any of the passengers desire it. This would, if the state of the ice permitted, render it possible to call at Clarence Head and the Carey Islands, and make at least a hasty search for the missing party; but a pleasure trip scarcely lends itself to serious Arctic exploration.

Prophecy with regard to the results of geographical exploration is too uncertain to be indulged in by modern critics, and in Arctic exploration particularly the conditions are so difficult to predict that success may attend the most inexperienced and worst equipped, while experience and all the resources of wealth and science would struggle in vain against adverse conditions. There are certain remarkable features about the new expeditions which distinguish them from most of the earlier efforts. Each has been planned and is being carried out by a man who is thoroughly in earnest, and whose reputation rests on his success. This is widely different from the case of a commander "ordered" to carry out the plans of others. Each expedition is small; Nansen's, which is the largest, comprises only thirteen men. Two of those which have already faced the awful monotony of the Arctic night have appliances for dissipating the darkness by the electric light—an advantage which can hardly be overestimated in its effect on the spirits of the men. Provisions and equipments have been greatly improved, even since the time of the Alert and Discovery and of the Jeannette. Most important of all, three of the expeditions are free from the responsibility of a ship. In all these ways the four serious attempts of this year have elements of success never combined previously. Their results will not be known for some time. News of Mr. Peary will certainly be received next autumn by the vessel to be sent up to Inglefield Gulf to bring him home if he considers his work satisfactorily finished. It is probable that Mr. Wellman also will return; but unless he should, by some scarcely credible good fortune, meet the crew of the Fram at his farthest north, we cannot hope to hear of Nansen for another year at least; and Mr. Jackson's scheme provides for a possible absence on his part for four years, though progress should be reported before the end of next year.

HUGH ROBERT MILL.

THE WELLMAN POLAR EXPEDITION.

THE Polar expedition, under Mr. Walter Wellman, which sailed from Tromso, Norway, on May 2, left Aalesund (which place was made its headquarters) on April 24, in the screw steamer Ragnvald Jarl, a stanch little vessel, specially constructed for whaling and sealing, and reported by Mr. Wellman to be "the best ship for ice navigation to be found in Norway, and next to the Fram (Nansen's ship) the best in existence." The vessel shipped all the stores, the aluminum boats and sledges, the dogs, and most of the members at Aalesund, the others joining her at Tromso. The *London Daily Graphic* gives the following particulars.

The object of the expedition is to attain, if possible, the farthest point north during the course of one season, and its leader deems it possible even to reach the Pole itself, owing to the advance being made from a point at a very high latitude—a latitude at which other explorers have had to turn back—and the extreme lightness of his equipment and stores, which will allow of rapid traveling over the frozen sea. The partly will be conveyed to Danes Island, on the northwest coast of Spitzbergen, where a depot in charge of Mr. Oyen and one man will be established. The other adventurers will push on in the ship to the edge of the Polar ice, there land with their stores, boats, sledges, and dogs, and thence advance northward for twenty-five days, when some of the members will return to the vessel in order to report progress, and steam in her to Tromso about the middle of July. The main body proceed on for another thirty-five days, at the end of which time it will turn back. The Ragnvald Jarl will meet the party early in October, and if all goes well, return with it to Europe. The ship has been chartered for any length of time her services may be required, is provisioned for twelve months, and fitted out for wintering in the north, should it become necessary to do so.

Mr. Walter Wellman, the organizer and leader of the present expedition, now thirty-five years of age, commenced life as a boy in a general store in Nebraska, and at twelve years of age was apprenticed to a printer. At fourteen he began to edit a newspaper. In 1884 he joined the staff of the *Chicago Herald*, and during the last five years has been correspondent and representative of that journal at Washington. Three years ago he undertook the leadership of an expedition sent by the *Chicago Herald* to the West Indies to discover and determine the spot at which Columbus first landed on American soil. He is a handsome, powerfully built man, possessed of untiring energy and determination, and consequently, is admirably fitted to be the leader of such an expedition.

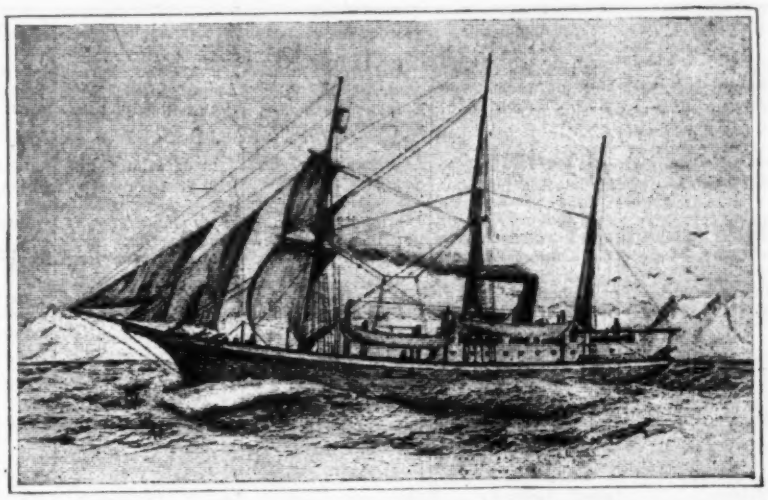
The expedition consists of Professor Owen B. French, aged twenty-eight, astronomer and topographer; Dr. Thomas B. Mohun, aged forty, surgeon and physician; Charles C. Dodge, aged thirty, naval constructor and photographer; Lionel W. Winship, aged twenty-one, engineer; Alfred S. Franklin (born Samuelsen), interpreter. Mr. Winship is a British subject, who, notwithstanding his youth, has traveled half the world over, and now turns from the glowing heat of Arabian deserts to the chill wastes of the frozen North. Franklin, so called, an American citizen, though Norwegian by birth, is slightly known in professional racing and speed skating circles in the States. Norwegians: Peter Oyen, aged thirty, geologist (will remain at Spitzbergen); Jens T. Dahl, aged twenty-five, mineralogist; Helge Alme, aged thirty, geologist; Fred Juell, aged twenty-four, and Trygve Heyerdahl, aged twenty-three philosophical students; Captain Emil Pedersen, pilot on the Polar pack; and H. Wastfeldt purser. Three men are also engaged for general duties, and the crew of the Ragnvald Jarl is nine men all told.

The outfit is unique in its way, consisting of three aluminum boats, fifteen aluminum and three wooden sledges, tents, Norwegian reindeer sleeping bags, ski and Canadian snow shoes, while the provisions consist of highly concentrated meats and vegetables in tins, but plenty of fresh seal, walrus, and bear's flesh will, no doubt, be obtainable. Winchester repeaters form the principal firearms, but some of the new Norwegian Schou's cylinder magazine rifles have also been taken. The boats are of the Jersey and Long Island type of lifeboat—two of them 18 ft. in length, 4½ ft. beam, and 2 ft. in depth; the other 16 ft. by 4 ft. and 2 ft. in depth. They weigh respectively 400 lb. and 350 lb., are furnished with runners, and thus can be dragged over the ice with ease. Ordinary wooden boats of their size would weigh about four times as much. Each of the boats has cost about £275. The sledges are flat sheets of metal, turned up in front, in shape like a toboggan of the so-called "Hudson Bay" pattern. They weigh 26 lb., and are convertible into boats by means of watertight cases which can be fastened on to them.

The dogs, now fifty-two in number, are Belgian, or rather from Belgium, of all sorts and descriptions and nondescriptions, and though, doubtless, admirable for draught purposes in Central Europe, they will probably prove to be entirely unfitted for Arctic work. The broad-footed dog of warmer climes cannot compete with the fox-footed Eskimo ("Eskimo" includes the Finn and Siberian dogs). Even in Norway foreign sporting dogs get chapped feet on the snow, or have to stop continually and eat the snow and ice from between their toes ere they can walk further, while sores thus created heal with difficulty during frost. Mr. Wellman has, in this respect, been singularly unfortunate in his choice, but, with American foresight, has taken a supply of moccasins wherewith to protect their paws. General experience, however, shows that when a foot is thus encumbered the dog sits down and bites off the shoes; and even should the beasts be trained to wear such coverings, no trial has, as yet, been made of the traction power of a booted dog. European dogs, too, are accustomed to good feeding daily, while the Eskimo can retain their strength for days without sustenance, and live on seal flesh, garbage, or offal, which would be rejected by the civilized animal.

The ship Ragnvald Jarl is a handy, substantial little craft, built for the whaling trade at Aalesund in 1873, a trifle over 98 feet keel, 24 feet beam, and nearly 11 feet depth of hold, 120 net register tons, 186 gross, rigged as a three-mast schooner, with engines of 22 horse power nominal, which at her latest trial gave her a speed of 7 knots. She has taken reserve portions of machinery, screws, etc., in the event of accident. She flies the stars and stripes, and the flag of the expedition, bearing the letters W. N. P. E.

Mr. Wellman has described his venture as a "pioneering expedition" which may pave the way for future scientific exploring parties. He has certainly chosen the best route to the most accessible point of land in the far North, and a dash thence over the Polar ice will very likely enable him, with his comparatively light loads, to attain a higher latitude than Parry did in 1827, provided he proceeds due north, but he must eventually be stopped, as Parry was, by the southward drift of the ice. Wellman's theory that the flow ceases for some eight or nine months of the year, and that in his advance northward he will have the advantage of traveling over motionless ice, has yet to be proved, and were this to be the case, Nansen's plans, which are based entirely on a constant drift, would be entirely upset. Should, however, Wellman find himself mistaken, he says, "We are prepared to take advantage of the circumstances, no matter what they be. If we cannot carry out our plans as originally intended, we can possibly effect our object in some other way." He thus reserves to himself the right to proceed in any direction he sees to be the fittest.



THE WHALER RAGNVALD JARL, CHARTERED FOR THE WELLMAN POLAR EXPEDITION.

THE BACILLUS ANTHRAX IN CALIFORNIA.

WHILE the Bureau of Animal Industry of the United States claims that California has no anthrax, it is of paramount importance to call their attention and that of the public in general to the fact that Dr. C. L. Bard has seen hundreds of cases in cattle and sheep, and treated many cases in human beings in California. The doctor in his paper states:

"I am prepared to say that the soil of certain sections of our State is polluted by the presence of the bacillus anthracis, and has been for more than twenty years, during which period there have been frequent outbreaks of the disease in animals, so frequent in fact that anthrax may be said to be enzootic in the district comprising the counties of Los Angeles, Orange, San Diego, Kern and Ventura. In my description of the appearance and existence of the disease, I confine myself to the results of my observations in my own country, where I have practiced medicine for more than a quarter of a century. In 1872 a sheep owner, residing near Bakersfield, placed in his band of sheep (five thousand in number) some bucks which had been imported from an infected district of France. Shortly after this acquisition, the animals began to die from

the effects of a disease which to the owner was unknown. Concluding that it might be due to local causes, he started toward the cooler country of the coast. He proceeded to San Fernando, and from there to the plains of Ventura county. In six weeks he lost more than one-half of his flock, and the localities where it grazed are infected to this day. They have been swept by fire, deluged by rain, torn up by the plow, exposed to the heat of southern sun, deserted for years at a time, but the resumption of their use as range has invariably resulted in an outbreak of the disease. One of these ranges, two years afer its infection by Edouart's band, was rented by a sheepman who placed on it a band of eight thousand sheep. Shortly after its occupation the malady appeared, and in two years' time, the owner, who was stubborn, deaf to advice from others, and determined to remain, lost every one of them. On the same ranch a few years later, the majority of a band of cattle, seven hundred in number, succumbed to the same disease. Last November a firm of cattlemen leased an infected ranch, upon which seven hundred and fifty indigenous cattle were at the time grazing. No manifestation of the disease had occurred for years. The importation of one hundred and ninety-five head from an infected locality but fifteen miles away was followed by the appearance of the disease, which virtually carried away every one of them. Nine hundred more were brought in from Arizona, and of these, six hundred perished, the remainder being saved by their removal. The process of infection since its inception has steadily progressed, so that many places in the mentioned counties are for the time unfit for grazing purposes. . . .

"Since the first appearance of the disease there have been at least one hundred cases of malignant pustule in Ventura county. They have corresponded in every particular to the description already given, and, with but one exception, were situated in exposed portions of the body. The majority of them were in the herders who had inoculated themselves while skinning dressed animals. The others were inoculated by fly bites. In this number were two ladies and two children I have never seen a case transmitted from man to man or from man to animal. All of my cases, with the exception of one, resulted in recovery. A microscopical examination of the blood, made six hours after the autopsy (in this fatal case), showed it swarming with the rod-shaped bacilli and their spores. . . .

"The treatment of the disease, as variously recommended, consists of excision, cauterization, deep injections of iodine, carbolic acid, potassic permanganate or corrosive sublimate in solution. Davies-Colley reports the successful use of ipecacuanha locally in form of powder, and internally in five grain doses every four hours. Muskett, who in South Africa treated fifty cases without a death, used it also. The treatment usually followed in California's infected districts has consisted in the hypodermic and local application of carbolic acid. During the last few years, however, I have relied upon deep crucial incisions and the application of a saturate solution of the mercuric bichloride, supplemented by the usual antiseptic dressing. In all cases stimulants, quinine and the tincture of the chloride of iron have been administered internally."—*Proceedings of the California State Sanitary Convention.*

MEANS OF PROTECTING PLANTS AGAINST BLIGHT AND INSECTS.

THE following so called Spray Calendar, sent out by the Horticultural Division of the Cornell University Agricultural Experiment Station, seems to us so useful that we give it entire, hoping that it may reach the fruit growers among our readers in time to save their crops from some of the dangers which each year is sure to bring.

In the preparation of this calendar the most important points regarding sprays have been selected and arranged in such a manner that the grower can see at a glance what to apply and when to make the applications. The more important insect and fungous enemies are also mentioned, so that a fairly clear understanding of the work can be obtained by examining the table below. When making the applications advised, other enemies than those mentioned are also kept under control, for only the most serious ones could be named in so brief an outline. The directions given have been carefully compiled from the latest results obtained by leading horticulturists and entomologists, and they may be followed with safety.

In this calendar some applications are italicized, and these are the ones which are *most important*. The number of applications given in each case has particular reference to localities in which fungous and insect enemies are most abundant. If your crops are not troubled, when some applications are advised it is unnecessary to make any.

By E. G. LODEMAN, Assistant Horticulturist, Cornell University Experiment Station, Ithaca, N. Y.

FORMULAS.

Bordeaux Mixture.

Copper sulphate	6 pounds
Quicklime	4 pounds
Water	40 gallons

Dissolve the copper sulphate by putting it in a bag of coarse cloth and hanging this in a vessel holding at least 4 gallons, so that it is just covered by the water. Use an earthen or *wooden vessel.* Slake the lime in an equal amount of water. Then mix the two and add enough water to make 40 gallons. It is then ready for immediate use. For rots, moulds, mildews, and all fungous diseases.

Ammoniacal Copper Carbonate.

Copper carbonate	1 ounce
Ammonia	enough to dissolve the copper
Water	9 gallons

The copper carbonate is best dissolved in large bottles, where it will keep indefinitely, and it should be diluted with water as required. For same purpose as Bordeaux.

Copper Sulphate Solution.

Copper sulphate	1 pound
Water	15 gallons

Dissolve the copper sulphate in the water, when it is ready for use. *This should never be applied to foliage, but must be used before the buds break.* For peaches and nectarines use 25 gallons of water. For fungous diseases.

Paris Green.

Paris green	1 pound
Water	250 gallons

If this mixture is to be used upon peach trees, [illegible]

For aphides or plant lice use kerosene emulsion on all plants.

PLANT.	First Application.	Second Application.	Third Application.	Fourth Application.	Fifth Application.	Sixth Application.
APPLE, (*Scab, codlin moth, bud moth.*)	When buds are swelling, copper sulphate solution.	*Just before blossoms open, Bordeaux. For bud moth, Arsenites when leaf buds open.*	*When blossoms have fallen, Bordeaux and Arsenites.*	*8-12 days later, Bordeaux and Arsenites.*	10-14 days later, Bordeaux.	10-14 days later, Bordeaux.
BEAN, (*Anthracnose.*)	*When third leaf expands, Bordeaux.*	*10 days later, Bordeaux.*	14 days later, Bordeaux.	14 days later, Bordeaux.		
CABBAGE, (*Worms, aphis.*)	*When worms or aphis are first seen, Kerosene emulsion.*	7-10 days later, if not heading, renew emulsion.	*7-10 days later, if heading, hot water 130° F.*	Repeat third in 10-14 days if necessary.		
CHERRY, (*Rot, aphis, slug.*)	As buds are breaking, Bordeaux; when aphis appears, Kerosene emulsion.	When fruit has set, Bordeaux. If slugs appear, dust leaves with air slaked lime. Hellebore.	10-14 days if rot appears, Bordeaux.	10-14 days later, Ammoniacal copper carbonate.		
CURRANT, (*Mildew, worms.*)	*At first sign of worms, Arseniles.*	10 days later, hellebore. *If leaves mildew, Bordeaux.*	If worms persist, Hellebore.			
GOOSEBERRY, (*Mildew.*)	*When leaves expand, Bordeaux.*	*10-14 days later, Bordeaux.*	*10-14 days later, Ammoniacal copper carbonate.*	*10-14 days later, repeat third.*		
GRAPE. (*Fungous diseases.*)	In Spring when buds swell, copper sulphate solution.	*When leaves are 1-1½ inches in diameter, Bordeaux.*	*When flowers are open, Bordeaux.*	*10-14 days later, Bordeaux.*	10-14 days later if any disease appears, Bordeaux.	10-14 days, Ammoniacal copper carbonate. Make later applications of this if necessary.
NURSERY STOCK, (*Fungous diseases.*)	*When first leaves appear, Bordeaux.*	*10-14 days, repeat first.*	10-14 days repeat first.	10-14 days repeat first.	10-14 days repeat first.	10-14 days, repeat first.
PEACH, NECTARINE, (*Rot, mildew.*)	*Before buds swell, copper sulphate solution.*	Before flowers open, Bordeaux.	*When fruit is nearly grown, Bordeaux.*	*5-7 days later, Ammoniacal copper carbonate.*	5-7 days later repeat fourth.	5-7 days later repeat fourth if necessary.
PEAR, (*Leaf blight, scab, psylla, codlin moth.*)	As buds are swelling, copper sulphate solution.	*Just before blossoms open, Bordeaux. Kerosene emulsion when leaves open, for psylla.*	*After blossoms have fallen, Bordeaux and Arsenites. Kerosene emulsion if necessary.*	*8-12 days later, repeat third.*	10-14 days later, Bordeaux.	10-14 days later, Bordeaux if necessary.
PLUM, (*Fungous diseases, curculio.*)	When buds are swelling, copper sulphate solution.	*When blossoms have fallen, Bordeaux. Begin to jar trees for curculio.*	*10-14 days later, Bordeaux.*	10-20 days later, Bordeaux.	10-20 days later, Ammoniacal copper carbonate.	*2-3 weeks before Plums ripen, Bordeaux, or Ammoniacal copper carbonate*
POTATO, (*Blight, beetles.*)	*When beetles first appear, Arsenites*	*When vines are two-thirds grown, Bordeaux and Arsenites.*	5-15 day later, Bordeaux.			
QUINCE, (*Leaf and fruit spot.*)	When blossom buds appear, Bordeaux.	When fruit has set, Bordeaux.	10-20 days later, Bordeaux.	*10-20 days later, Bordeaux.*	*10-20 days later, Bordeaux.*	
RASPBERRY, BLACKBERRY, DEWBERRY, (*Anthracnose.*)	Before buds break, copper sulphate solution.	During summer, if rust appears on leaves. Bordeaux.	(*Orange or red rust is treated best by destroying the plants.*)			
STRAWBERRY, (*Rust.*)	*As first fruits are setting, Bordeaux.*	As first fruits are ripening, Ammoniacal copper carbonate.	*When last fruits are harvested. Bordeaux.*	Repeat third if foliage rusts.		
TOMATO, (*Rot, blight.*)	At first appearance of blight or rot, Bordeaux.	Repeat first if diseases are not checked.	Repeat first when necessary.			

Black knots on plums or cherries should be cut out and burned as soon as discovered.

pound of quicklime should be added. Repeated applications will injure most foliage, unless lime is added. *Paris green and Bordeaux can be applied together with perfect safety.* The action of neither is weakened, and the Paris green loses all caustic properties. For insects which chew.

London Purple.

This is used in the same proportion as Paris green, but as it is more caustic it should be applied with the lime or with the Bordeaux mixture. Do not use it on peach or plum trees. For insects which chew.

Hellebore.

Fresh white hellebore	1 ounce
Water	3 gallons

Apply when thoroughly mixed. For insects which chew.

Kerosene Emulsion.

Hard soap	½ pound
Boiling water	1 gallon
Kerosene	2 gallons

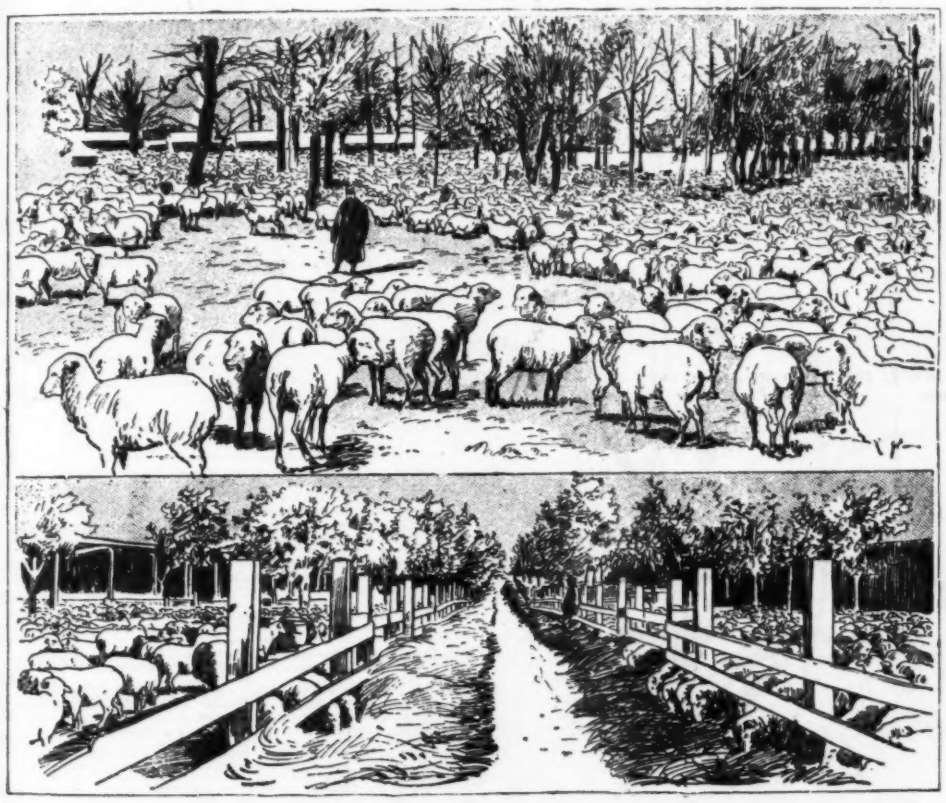
Dissolve the soap in the water, add the kerosene and churn with a pump for 5 to 10 minutes. Dilute 10 to 15 times before applying. For insects which suck, cabbage worms and all insects which have soft bodies.

I. P. ROBERTS, Director, Ithaca, N. Y.

AMERICAN SHEEP.

DURING the last few years the sheep industry in Montana and Dakota has grown to enormous proportions, though since the agitation for free wool many men have given up sheep raising. Still, experts place the number of sheep in Montana alone between three and five million head. During the winter the ranchman only attempts to keep his sheep alive, as grass and water both run short and food is difficult to obtain. Two years ago some Montana men sent a flock of 10,000 sheep to Minneapolis to be fattened during the winter on the waste from the flour mills of that city, and the experiment turned out so well that the number sent is now being largely increased. Our illustrations represent the sheep in the Minneapolis stock yards. The sheep are split up into bands, as the ranchmen call them, of about 5,000 in a band, as the sheep are thus more easily managed than if they were all penned together. The ranchmen who look after these flocks are men of great experience and judgment, and have the finest bred sheep dogs obtainable to help them in the management. One thoroughly good dog and its master can look after 23,000 sheep. When the sheep arrive at Minneapolis and the other towns near they are in poor condition, but they rapidly put on flesh, and gain on an average 8 lb. to 10 lb. a month. The sheep are fed on "screenings" or waste flour from covered bins about 6 ft. long and as many high, with a long narrow slit at the bottom into which the "screenings" fall. In the severe weather the yearlings, and also the older sheep, go into sheds which are placed all over the yards, but even when the mercury is at 20 deg. below zero the thick-fleeced animals will munch their hay in the open. The United States consume some 600,000,000 pounds of wool in a year, about half of which is produced in the country, and the number of sheep is placed at 45,000,000. It is feared by the native producers that if wool is placed on the free list the Western States will be beaten out of the field by the cheaper wool from Australia. The reason for this is that the ranchmen pay more attention to the fleece than to the mutton, and so lose much that they might make out of the sale of the carcasses.—*Daily Graphic.*

A Rancher and his Flock.



A Hay-bordered Lane in the Open.

WINTERING SHEEP FROM WESTERN RANCHES IN THE MINNEAPOLIS STOCK YARDS.

IRRITABILITY OF PLANTS.

AT the last meeting of the Versammlung, or meeting of German naturalists and physicians, Prof. Pfeffer gave an address on the above subject—one which his own work has done so much to elucidate. Irritability, he points out, is not an exceptional characteristic found in special plants; it is a fundamental quality existing in all plants, from the highest to the lowest, although its manifestations in great measure escape superficial observation. The sensitiveness of a mimosa, the curling up of tendrils when touched, or the curvatures of growing internodes in response to light and gravitation, are well known and easily observed instances of irritability. But the less obvious reactions are of equal interest.

Pfeffer instances the remarkable researches of Hegler on the effect of mechanical traction on growth stems, which, when stretched by a weight, gain mechanical strength through the development of the mechanical tissues, which follows as a response to the pull to which they are subjected. Pfeffer has recently shown that resistance put in the way of growing roots increases enormously the energy with which they grow. Other instances of adaptive stimulation escape ordinary observation because of the microscopic character of the reaction. For instance, the extraordinary directive influence of malic acid on the movement of the antherozoids of ferns, or of potash salts on the movement of bacteria. In the same way the irritability of the higher plants is commonly exhibited by movements so slow as to be imperceptible to the naked eye. It is no wonder indeed that the layman does not realize that plants have the same power of reaction to stimulation as animals. Pfeffer remarks, in a striking passage, that "Man would not have inherited such a belief, if the world of plants had been visible to him from childhood as it appears under the higher powers of the microscope. Then he would have had constantly before his eyes the innumerable host of free swimming plants and other low organisms; and the hurrying bacterium turning and rushing toward its food would have been as familiar as the beast of prey springing on its victim. To such eyes the growing stems and roots of the higher plants would have appeared circling with a search-like movement, and many other rapid reactions to stimulus would have been apparent. Under the influence of a multitude of such images, irritability would, without a doubt, have seemed to be a self-evident and universal property of plants."

He goes on to point out how necessary it is to clear our judgments in regard to reactions in which movement is the observed factor. A bacterium rushing across the field of the microscope moves nothing like so fast as a snail, yet it moves rapidly in reference to its own minute dimensions, since it will traverse three to five times its own length in a second, while man at a walk only gets over half his height per second.

The one thing common to all the varied stimulus reactions is that in each of them we recognize a phenomenon of release (Auslosung-), or, to put it in familiar language, a trigger action. Stimulation is therefore release action in living matter.

In classing irritability among trigger effects, we express the fact that the stimulus is only the releasing agent; the nature of the effect depending on the specific qualities of the organism. Just as the touch of a finger may, in the case of human machines, either blow up a powder magazine, start a steam engine, or set a musical box a-playing, so in the case of plants, the same stimulus produces different or even opposite effects on different species.

In machines, as in the living organism, every degree of disproportion between the releasing agent and the amount of energy released occurs. The latent period again is not peculiar to the manner of reaction of organisms, but finds a place in machines of human manufacture. In a clock set in action a period elapses before the striking of the hour (part of released action) comes into play.

It is again no peculiarity of the organism that reaction to stimulus is usually adaptive, since machines are adaptive and self-regulating. The adaptive character of most reactions is as comprehensible as the failure of an organism to adapt itself to conditions not met with in nature. A bacterium being lured to certain death in a mixture of corrosive sublimate and extract of meat is an example of what is meant.

Doubts may arise whether or not certain processes are to be called release actions. Take the case of enzymes. From the point of view of the plant they serve to bring about a wide change at the cost of a relatively small amount of energy. Or take a simpler instance. The tensions which allow the capsule of impatiens to burst or the stamens of parietaria to explode are the product of vital activity, and have, moreover, an adaptive quality. But the release is purely mechanical; there is nothing like *perception* in the ordinary sense of the word, so that these phenomena differ from the reaction of mimosa. Pfeffer, therefore, prefers not to consider the explosions of mimulus, parietaria, etc., as cases of irritability, while he acknowledges that there is no real objection to the word irritability having a wide enough meaning to embrace such cases. All that matters is that we should have a clear conception of the existence and importance of release action in the vegetable organism.

Pfeffer points out that in his "Physiology" (1881) he laid down the same general principles that are developed in the present address, together with examples in various regions of change, and that even earlier, in his "Osmotische Untersuchungen" (1877), he expressed, without reserve, the same views as applicable to the phenomena of life generally. He claims for these views a practical priority in botanical literature, although he fully recognizes that Dutrochet, in 1832, set forth perfectly clear and sound views on the subject.

In 1881, too, he used the word *Reiz*, *i. e.*, stimulus effect, as equivalent to physiological release action; and he used the expression *Release* intentionally, because of the mystic conception attaching to the terms stimulus and irritability. In fact, he would at the present moment throw over altogether the word *Reiz*, if it were not that the time has gone by for those mystic conceptions of life which are inconsistent with the law of the conservation of energy.

Pfeffer goes on to point out that when, in 1882, Sachs set forth his belief in the general existence of irritability, and in its necessity for the machinery of the organism, he spoke of it not as a phenomenon in the wider category of release actions in general, but as a specific peculiarity of living organisms. Sachs, according to Pfeffer, holds the specific character of irritable organs to be not so much their unstable equilibrium as the fact that after stimulation they return automatically to the labile condition. Pfeffer claims that this definition does not apply to many undoubted cases of stimulation. When callus is produced by injury, or when adventitious roots are developed in response to certain stimuli, there is no such automatic return, but a permanent alteration.

To produce a stimulus reaction, a change in external or in inner conditions is necessary. The sensitive plant does not react to steady pressure, but to variation in pressure.

An analogous state of things is found when a plant in a condition of cold rigor is made to grow by heat. For the change in temperature is merely a stimulus, since it only releases activities which are carried on by the energy at the plant's disposition, not by the heat. At a constant temperature the plant is in a statical condition of irritability, which is a necessary condition for the realization of vital activity.

If the results of temperature changes are not generally recognized by botanists as phenomena of stimulation, this is only a proof of the need of accurate conceptions in this branch of physiology. The association of the word with strikingly visible phenomena is partly to blame for this. Every one recognizes that, for instance, in the opening of the crocus or tulip flower, the change of temperature is a stimulus. In these instances the action of heat may be compared to the regulation of certain machines of human construction by the heat expansion of a metallic rod.

Even when the increased temperature, by increasing molecular action, brings about a union with oxygen, still the temperature change is only the indirect cause of the combustion; and this reasoning applies to respiration.

In a similar sense the addition of a salt of potassium to a culture fluid produces a release action in a plant in which growth was checked by the absence of this element.

Pfeffer has some interesting remarks on the condition of irritability of organs in a condition of equilibrium; for instance, on the continued action of the gravitation stimulus on a geotropic organ growing vertically. Bacteria are less sensitive to the attraction of meat extract when themselves immersed in dilute extract; that is to say, the homogeneous medium, which has no directive action, shows its effect in diminished irritability. The same is true of heat, which stimulates when it varies, and which, when constant, is a necessary condition for certain states of irritability. The idea is not a new one, for no less a man than Johannes Muller (Pfeffer points out) defined the formal conditions of animal and plant life as *Lebensreize* or *integrirende Reize.*

The stimulus need not come from the outside, for just as a clock by internal machinery strikes at intervals so in the organism combinations occur which function as stimuli for certain effects. These are naturally obscure, and for this reason we do well to fix our attention principally on external stimulation: but it can hardly be too much impressed on us that the development and ordered activity of the living body is inconceivable without the co-operation of stimulus from the inside.

With regard to stimulus and reaction, we are in the position of a man, ignorant of mechanics, who sets a machine in motion by a touch of his finger, and who has no idea whether the effect is due to a falling weight, to water power, or to steam. Considerations of this

sort make us realize our ignorance, so that when a new result is observed (in a case of stimulation) we do not even know whether the cause is to be sought in the perception of the stimulus or in the machinery of reply. While denying himself the discussion of cognate points, Pfeffer finds room to call attention to one or two interesting points of resemblance in the irritability of plants and animals.

Thus, for instance, in plants as in man, an increase in the stimulus produces a dulling of sensitiveness. Just as a beggar is stimulated by the gift of a shilling, which on a rich man has no such effect, so a starving bacterium is stimulated to movement by excessively minute quantities of meat extract, while the same organism living in the midst of plenty can only be stimulated to similar movement by an absolutely greater quantity of extract. In the irritability of plants we find, in fact, the relations which are expressed in Weber's law—a proof that the relation in question has nothing to do with the higher psychic functions.

A plant or a plant organ is never sensitive to a single stimulus only; thus during a geotropic curvature mechanical traction may bring about a strengthening of cell walls, and an injury may produce protoplasmic movement. Here lies a proof that different stimuli do not produce one and the same effect in a given cell, that, in fact, the cell does not react like our eyes, in which the most varied stimuli produce the effect of light. In the case of plants there can be no question of such a limited capacity—of specific energies in the sense of Johannes Muller.

The development of distinct organs of sense whose function is the perception of a single agent is well known to be as little characteristic of plants as of the lower forms of animal life. But distinct organs of sense are no more a condition of irritability than they are of life. Indeed, plants exhibit a variety of sensibilities equal to that of animals, while in delicacy of perception the vegetable kingdom has the advantages. Bacteria are attracted by a billionth or trillionth of a milligramme of meat extract or of oxygen, infinitesimal quantities which we cannot weigh, and of which indeed we cannot form any adequate conception. It is just because the whole secret of life is contained in protoplasm that the simplest organism, such as a bacterium, can be the theater of as rich and varied a play of stimulus and reaction as the most complicated plant.

CYPRIPEDIUM MACHROCHILUM GIGANTEUM.

A GRAND addition to our long-tailed cypripediums. This is a hybrid obtained by crossing C. grande with C. caudatum Lindeni. The leaves are 15 to 18 inches long by two broad, stout, and deep green. The scape, carrying several flowers, is about two feet high. The dorsal sepal curls forward in yellowish green, veined with deep green, long and pointed; the ventral sepal is larger and broader, but much paler in color. The petals are green at the base, shading to deep rose and crimson, twisted, and about 15 inches long. The lip is of immense size, white inside, and spotted on the overlapping lobes, with green and deep reddish-brown; the inside of the lip is at the base freely spotted with deep rose, the outside is creamy white and green, faced with a suffusion of scarlet on the green. F.C.C., R.H.S., May 8. Messrs. J. Veitch & Sons.—*The Gardeners' Magazine.*

[FROM THE NEW YORK SUN.]

NEWS ABOUT ANOTHER WORLD.

THE great Lick telescope has just added another to its long list of important discoveries. Prof. Barnard has measured the diameters of three of the principal minor planets, or asteroids, Ceres, Pallas, and Vesta, and has found that, contrary to the opinion which has heretofore prevailed, Ceres is the largest of all these little worlds, its diameter being about 600 miles. Previous estimates have made its diameter only 200 or 300 miles. Ceres is now fairly well situated for observation, being a few degrees southeast of the star Delta in the back of the Lion, which crosses the meridian early in the evening. But even a telescope of considerable power makes no interesting revelations when turned toward Ceres, for the planet is so small that it appears in the field of view only as a faint star. It is reserved for telescopes of the first magnitude to reveal its round white disk, where no markings indicative of the presence of features resembling those of the earth or the moon have yet been detected. Prof. Barnard remarks that there is nothing in the appearance of Ceres, or its sister asteroids, to suggest the existence of any specially dense or extensive atmospheres surrounding them.

Ceres was the first of the asteroids to be discovered, and it was found on the first day of the nineteenth century. Situated in the midst of the broad gap of space that lies between the orbits of Mars and Jupiter, its mean distance from the sun is about 257,000,000 miles.

There is a theory according to which so small a world as Ceres cannot have an atmosphere, or at least cannot retain one permanently. If we suppose the mean density of Ceres to be the same as that of the earth, then the force of gravity on its surface is less than one thirteenth of its force on the earth, and any particle moving away from the center of Ceres with a velocity of 2,750 feet in a second would never stop and never go back. But the velocity with which the molecules of oxygen and nitrogen vibrate is believed to exceed 2,750 feet in a second; consequently if Ceres had an atmosphere composed of those gases, the outer molecules at the upper surface of that atmosphere, when their direction of vibration carried them away from the center of the planet, would not cease moving in that direction, and, meeting no obstacle, would pass out into space. In the course of time all of the molecules, upon reaching the surface of the atmosphere, would escape, and Ceres would remain stripped of its airy mantle.

Yet, if we could manage to get to Ceres, and find means of sustaining life upon it, we should perhaps discover how nature deals with such difficulties when she makes a world only 600 miles in diameter. Possibly from another view point than ours Ceres would not seem so absurdly little. It is not much smaller in comparison with the earth than the earth is in comparison with Jupiter. What would people on Jupiter think of such a trifling bit of terraqeous vanity as the earth?

I have assumed, for the sake of an easy calculation, that the mean density of Ceres is the same as that of the earth, but in truth it is probably much less. All of the planets that are further from the sun than the earth is are less dense than our planet. If the whole system was formed from an original widely expanded nebula, the heaviest materials would naturally settle toward the center. We know that the sun weighs less than the earth, bulk for bulk, but the reason is because the sun is still so hot that all its substance remains in the form of gas and vapor. When it has become solid its density will exceed the earth's. The innermost planet, Mercury, is heavier than a globe of lead of equal size would be, while the outermost planet, Neptune, weighs about as much as an equal globe of water. The progression is by no means regular; but there can be little doubt that Ceres, situated so far from the sun, is composed of comparatively light materials. We should not expect to find gold on Ceres. Gold is a heavy weight, and its natural home is Mercury or the sun. It even seems to have had doubts of the propriety of stopping at the earth.

Ceres is the leader of a ring of planets which seem to be absolutely numberless. Hundreds have been discovered; thousands are believed to exist. A few years ago, when astronomers were counting and mapping the stars with telescopic aid alone, they continually stumbled upon new asteroids; now that the heavens are being photographed, dozens of these little worlds previously unknown leave their luminous tracks upon the sensitive plates exposed to the sky at the observatories. The old idea that they are the fragments of a planet which has been blown to pieces was at one time abandoned, but more recently it has been revived in a new form. It has been pointed out that on the supposition of a single explosion it is impossible to account for the present distribution of the asteroids, but that a series of explosions might answer. In that case the original planet, which may have equaled Mars in size, must first have been blown up, and afterward the pieces must have continued to explode one after another, and again and again, perhaps, until they were reduced to their present size. According to this theory, Ceres is simply the largest fragment remaining of an ancient world that may have had an atmosphere and water and other things that pertain to a properly regulated and well furnished planet.

CYPRIPEDIUM MACHROCHILUM GIGANTEUM.

Did it have inhabitants also? If we could go to Ceres, might we pick up among its shattered and blasted rocks some relic that, like the bronze knives of Hissarlik or the ivory carvings of Dordogne, would tell the story of a vanished race?

What a singular fate for a planet—to be blown to fragments! We have been told that ours shall melt with fervent heat, and astronomy knows several ways in which that might be brought about. But for a world to explode and hurl its odds and ends broadcast over the firmament—the modus operandi of that catastrophe remains to be discovered.

The chief difficulty, however, is to account for the first rupture. Comparatively slight explosive energy would be required to blow the fragments themselves to pieces. I have mentioned that on Ceres a velocity of 2,750 feet in a second would be sufficient to enable a moving particle to escape from the attraction of the planet. But the vast majority of the asteroids are almost microscopic in comparison even with Ceres. Hundreds are probably only five or ten miles in diameter, thousands are undoubtedly much smaller still. Now, on an asteroid five miles in diameter, supposing again for simplicity's sake that its density equaled the earth's, a velocity of only twenty-three feet in a second would suffice to enable a moving body to escape from the asteroid. The muscular force of a man would be enough, then, to tear such a planet to pieces and throw its fragments into separate orbits! The motions of the four largest asteroids, including Ceres, are such as may be reconciled with the result of a single explosion modified by the disturbing attraction of the larger planets. It might be supposed then that they, on account of their size, have suffered no second disruption, while the smaller fragments produced by the original explosion have been broken again and again.

Yet the mystery of the first great convulsive dismemberment remains. Yes; but mystery is the soul of discovery.

GARRETT P. SERVISS.

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TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Means of Protecting Plants against Blight and Insects.—Reproduction of the "spray calendar" sent out by Cornell University for use by fruit growers, telling them what insecticide mixtures to apply and when to apply them to each kind of plant. 15396

II. ASTRONOMY.—News about Another World.—Recent measurements of asteroids executed at the Lick Observatory. 15398

III. BIOGRAPHY.—His Excellency Senor Don Luis Cordero, President of the Republic of Ecuador.—Life of a distinguished man, President of the South American Republic of Ecuador.—With 1 illustration. 15400

IV. BOTANY.—Irritability of Plants.—Curiosities of plant life, such as shown by the sensitive plant. 15397

V. CIVIL ENGINEERING.—Deep Boring near Freidstadt, Austria.—A very valuable paper on European practice in boring artesian wells, with exhaustive data. 15397

VI. FARMING.—American Sheep.—Sheep raising in the West.—How the sheep are cared for in winter.—2 illustrations. 15397

VII. GEOGRAPHY AND EXPLORATION.—The Arctic Expeditions of 1894.—What may be looked for from the exploring expeditions of the present year. 15395
The Wellman Polar Expedition.—Full account of the ship and exploring plant of this expedition to the north.—1 illustration. 15395

VIII. GEOLOGY.—Oil in Colorado and Wyoming.—Production of oil in the West, with statistics of the oil wells. 15396

IX. HORTICULTURE.—Cypripedium Machrochilum Giganteum.—A new addition to the greenhouse plants.—1 illustration. 15399

X. MECHANICAL ENGINEERING.—Vosper's Oil Engine.—A steam launch engine giving 15 actual horse power.—4 illustrations. 15397

XI. METALLURGY.—Nickel—Its History, Uses, and Distribution. By A. G. CHARLETON, A.R.S.M.—First installment of a recent Society of Arts paper on the history of this method from the standpoint of a metallurgist. 15401

XII. MISCELLANEOUS.—Telephone Rates in Europe.—Valuable particulars of charges in different countries of Europe for telephones. 15396

XIII. PHARMACY.—Some Thoughts on Pharmacy as a Profession. By SAMUEL P. SADTLER, Ph.D.—An interesting paper for young men studying for this profession. 15405

XIV. PHYSIOLOGY.—Right and Left Sightedness.—Simple method of examining the eyes for recognition of this quality.—3 illustrations. 15391

XV. RAILROAD ENGINEERING.—Gas Motors for Street Railways.—Comparison of expenses of different systems of running street cars, from results obtained in Germany. 15399

XVI. SANITATION.—Hotel Hygiene.—How to keep hotels healthy, with special reference to infectious diseases. 15393
The Adulteration of Food.—By H. W. WILEY, Chemist of the United States Department of Agriculture.—Continuation of this authoritative paper, pointing out the limitations to legal enactments in the direction of securing purity of food. 15402
The Bacillus Anthrax in California.—Infected districts of the West and treatment of the trouble. 15706

XVII. TECHNOLOGY.—Artificial Fuel Gas.—By HENRY WURTS, Ph.D.—The manufacture of water gas.—Its theory and history. 15391
Machinery for Charging and Drawing Gas Retorts.—A machine for putting coal into gas retorts in coal gas works.—3 illustrations 15403

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